OCTOBER, 1941

ORGANIC FINISHING

SECTION OF METAL FINISHING

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DEFENSE PLUS CIVILIAN NEEDS— ZAPON'S OBLIGATION

Defense demand for many raw materials comes first. That's an obligation which we accept, of course, with no reservations. Like other manufacturers we are confronted with serious problems of supply. To offset these conditions insofar as is humanly possible, we are faced with the necessity of finding or developing other materials to replace those now unavailable. While we are trying to make these substitute coatings fit existing customers' finishing schedules as closely as possible—our customers in turn will—in many cases—have to alter their existing practice to get the most out of the new materials.

Zapon is keenly aware of its double obligation, first to defense needs and second to our customers' wants. Every facility at our command is being bent to honor this twofold obligation. Disregarding any temporary gains to be had from a seller's market, we are employing our technicians, our equipment and experience to fill the demand for finishes, using materials now available.

For the customer to reap the greatest good from our efforts to serve him, the closest cooperation between us is paramount. Only by working together with utmost frankness and respect for each other's problems, may we be able to find solutions to the critical conditions posed by the times. Customers can help us get needed materials for their requirements by advising us of priority extensions as promptly as possible.

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Weathering the Storm

If there is a finishing superintendent who will weather the storm of shortages, substitutions, etc., it will be the one who in the past has kept an open mind on new finishing materials and methods. It will not be he who has subscribed to the policy that, "we are satisfied with our present finishing materials, ovens, spray guns, etc., and therefore are not interested in anything new or different." It will be he who has been willing to try things out.

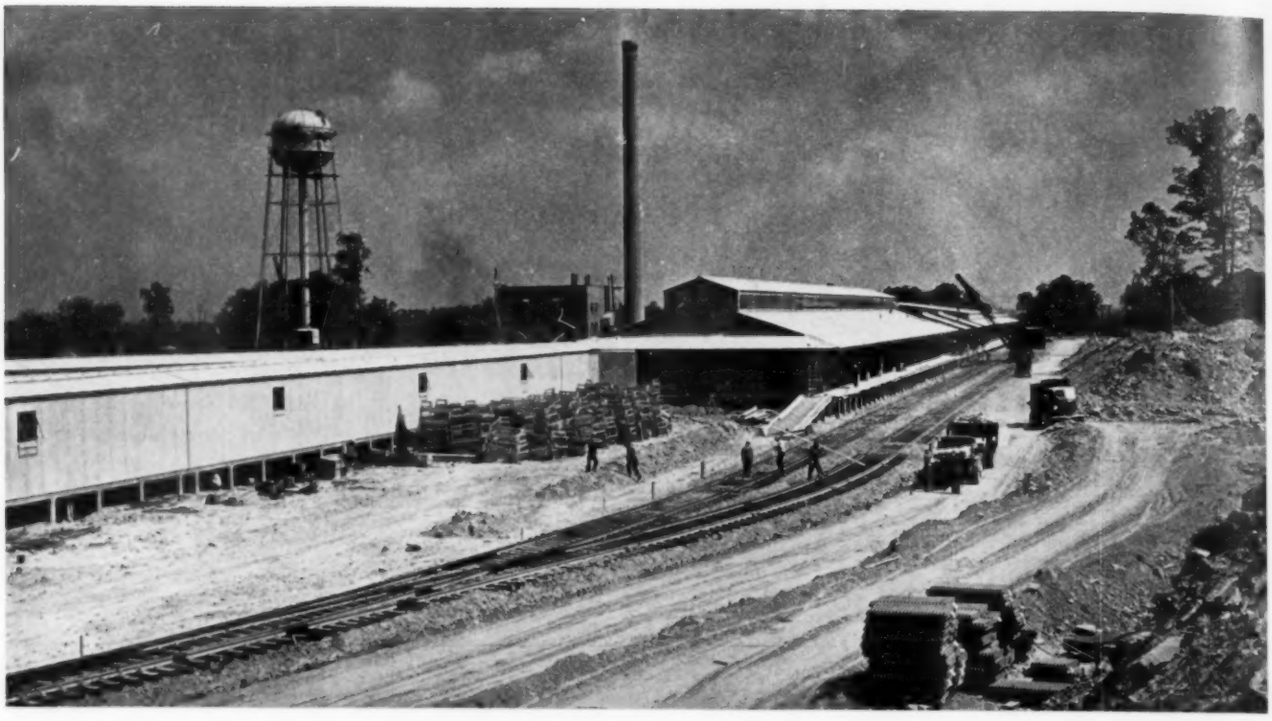
Such a finishing superintendent will be in an excellent position to carry on, in spite of difficulties, for three reasons. First, because of his progressive interest in improvements in finishing, his department will probably be efficient and flexible in operation rather than one in which production may be paralyzed by any change from regular routine.

Secondly, he will have become familiar with a number of different finishing materials from a number of suppliers. If material A from one of his suppliers becomes unavailable, he is acquainted with their material B and can possibly obtain it and do an acceptable job. If supplier X suddenly informs him that the lacquer or enamel or japan which he has been purchasing can no longer be made, then supplier Y, with whom he has worked in the past, can probably help him out.

Finally, and in our estimation this is the most important point, he will have developed in himself and in his department an ability to make changes on short notice and to make rapid evaluations of materials and methods. Such an ability is not developed overnight. It requires time, experience in carrying on tests and trials while maintaining production, the development of a complete knowledge of the requirements of the particular type of finishing being done.

Fortunately, more of those in charge of finishing operations fit the above description than not, as witnessed by the finishing done today. The finishing industry should take the present situation, and possibly an even worse one if it should develop, in its stride.

L. H. LANGDON, *Publisher* • T. A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*



View of One of the Shell and Bomb Loading Lines.

FINISHING SHELLS AT RAVENNA ORDNANCE PLANT

By Dr. Walter R. Meyer

Editor, Metal Finishing
New York, N. Y.

Huge Project

The Ravenna Ordnance Plant, the largest shell-loading plant in the world, was begun in August 1940. It is located in northeastern Portage County, Ohio, which was formerly ground used for cattle grazing and agriculture. The entire project of 42 square miles, now largely completed, is for loading of various types of artillery shells and bombs. The entire project is owned by the Government and operated by Atlas Powder Company. Lt. Col. R. S. Chavin is Commanding Officer and Constructing Quartermaster and W. E. Fletcher of Atlas Powder Company is General Manager of Operations.

The entire project requires facilities equivalent to a medium sized city. Over 100 miles of highway connect various areas and over 130 miles of standard gauge railroad track are within the plant area. The plant has its own huge sewage system which includes two large disposal plants. A large laundry is capable of handling twenty-five to thirty thousand uniforms daily. Figure 1 shows part of one of the shell-loading lines.

Finishing of Shells

INTRODUCTION

The shell finishing project was a result of the collaboration of engineers and chemists of the Zapon Division of the Atlas Powder Company, Stamford, Conn., who developed the finishing material, The DeVilbiss Company, Toledo, Ohio, who manufactured and engineered the mechanical portions of the equipment and the C. M. Hall Lamp Company, Detroit, Mich., whose engineers cooperated with The DeVilbiss Company in the development of the special infra-red radiant energy drying ovens. The entire installation was done in cooperation with Wilbur Watson and Associates, the general architects and engineers, on the project. The equipment was fabricated and installed for the Hunkin-Conkey Construction Company, the general contractors. There are three load lines in operation at Ravenna. The first handles shells from 75 millimeter to 105 millimeter size and several types of fragmentation bombs. Empty machined shells are furnished Ravenna by many shell manufacturers. They arrive coated with a suitable primer on the outside and with a black, acid proof coating on the inside. Before being loaded with explosive, the shells are finished with the equipment which is the subject of this story.

PRELIMINARY TREATMENT

Inasmuch as the shells must be finished during all types of weather, heating facilities are provided to warm the shells to room temperature or slightly above room temperature preceding the finishing operations. The shells are loaded on trucks which hold sixty shells each and they first pass through a warming oven which uses C. M. Hall Lamp Company's Thermalamps as source of heat.

Incoming shells are in a separate room and pass into the cleaning room through the previously mentioned warming oven, which consists of a battery of 250 watt radiant energy lamps. This preliminary warming serves to drive off any condensed moisture, and in addition, helps to assure a uniform finishing schedule which would possibly be upset by having the shells considerably colder than room temperature. The shell threads are cleaned and the shells pass singly on a conveyor into the finishing room.

Finishing Material

The finishing material used is a base finish to protect the shell against subsequent corrosion in storage or in field service. Drying features of the solvents used and the finishing material itself were correlated with the finishing cycle. After the shells are sprayed, about ten seconds' time is required for the shell to be transported from the spray guns to the entrance of the infra-red radiant energy drying tunnel.

The time required for curing of the finish is three minutes and the entire time for a complete cycle of the spindle conveyor is six minutes. At the end of the run, the masks and shells are removed manually and the shells placed on the loading racks for transportation to the explosive filling stations. The finishing material and finishing procedure, therefore, had to be correlated in such a manner that the shell finish was dry and hard after the finishing cycle. The shells on the unloading end of the system are sufficiently cool so that they can be handled by the operators without the use of protective gloves.

The shell finishing material is supplied under Army Specification, and it was the intent of the Zapon Division of the Atlas Powder Company to formulate the best possible material for finishing shells under this specification.

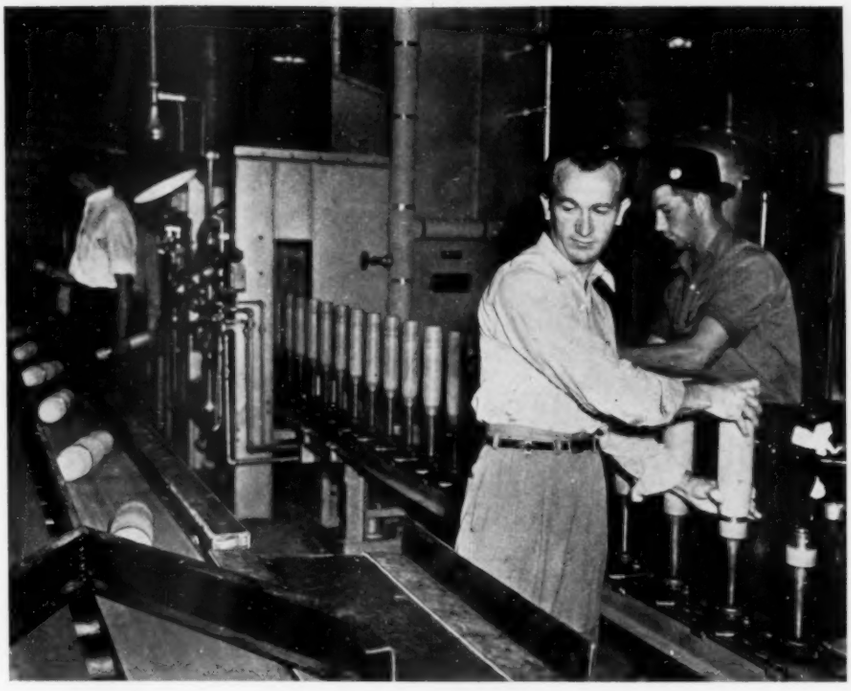


Fig. 1. The photograph shows the incoming shells on conveyor belt at left and being loaded onto spindles for passage through the spray booth and subsequent drying tunnels.

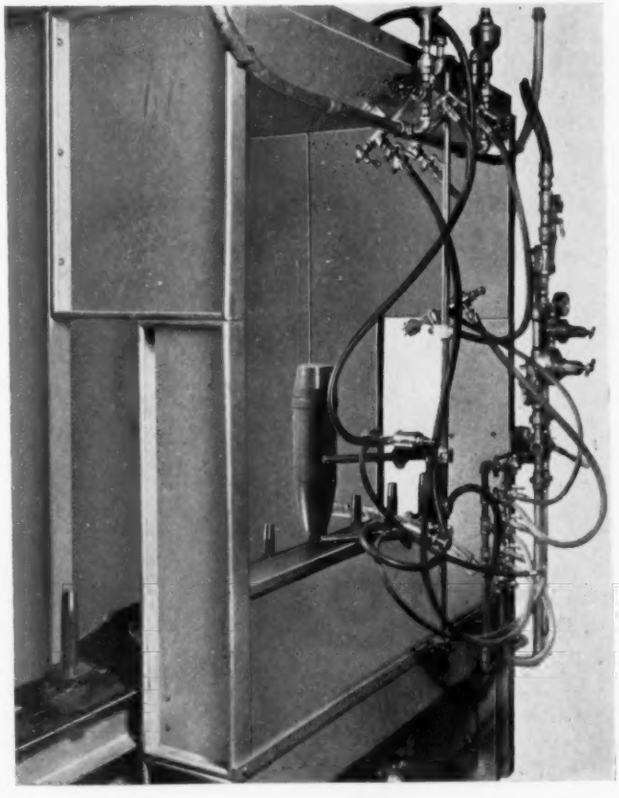


Fig. 2. View of a shell in spraying position and the equipment by means of which it is automatically coated.

SHELL PAINTING

The shells are painted with a lacquer enamel by means of two special automatic spray machines developed by The DeVilbiss Company. Before painting, a protective masking band is applied to the portion of the shell serving as a guide for the shell in the rifling of the gun. These machines are identical in design and are so placed that the spray stations of each can be observed simultaneously by a single individual. The machines are located on either side of a belt conveyor which carries the shells into the building. The rotating spindles of these machines are mounted on chain-on-edge conveyors which are each approximately 85 feet long. This conveyor chain has special side bars which slide on a lubricated track. The rotating spindles, which extend down through the center of the chain, are held in a proper vertical position by guide bars which extend the entire length of the conveyor. These guide bars are adjustable for wear.

The spindles turn on tapered roller bearings and are driven by a ball bearing explosion-proof motor which has been approved for extremely hazardous location by the Underwriters' Laboratory.

These spindles move through the spray stations at a speed sufficient to handle 2,000 shells of a single size per hour. The chain-on-edge conveyors, however, are equipped with adjustable speed drives to operate at from 60 to 120 per cent of their normal speed, to permit increase or decrease in the production rate when desired. Each conveyor drive is powered with ball bearing explosion proof electric motor, with highest safety rating for a hazardous location of this sort. A shear pin on each main conveyor drive insures against damage to the mechanism if something should accidentally interfere with the movement of the conveyor. All the conveyor shafts are mounted in self-aligning, ball bearing pillow blocks, and lubrication is by means of the Alemite System.

Each spray station is equipped with four automatically actuated spray guns, with provision for the installation of a fifth if the need should ever arise. An ingenious mechanism has been installed on both conveyors which automatically keeps the guns from spraying any unloaded spindle as it passes the spray station. This is an important feature of DeVilbiss automatic shell painting machines, for it prevents the fouling with paint of the holding part of unloaded workholders, which must always be kept clean to prevent a consequent fouling of the nose fuse threads. It further prevents the wastage of paint, and gives the operators a chance to skip spindles if desired or to leave the machine when necessary without stopping its operation. The rate of rotation of the spindles is adjustable from 160 to 414 R.P.M., so that each size of shell can be coated in the most efficient manner.

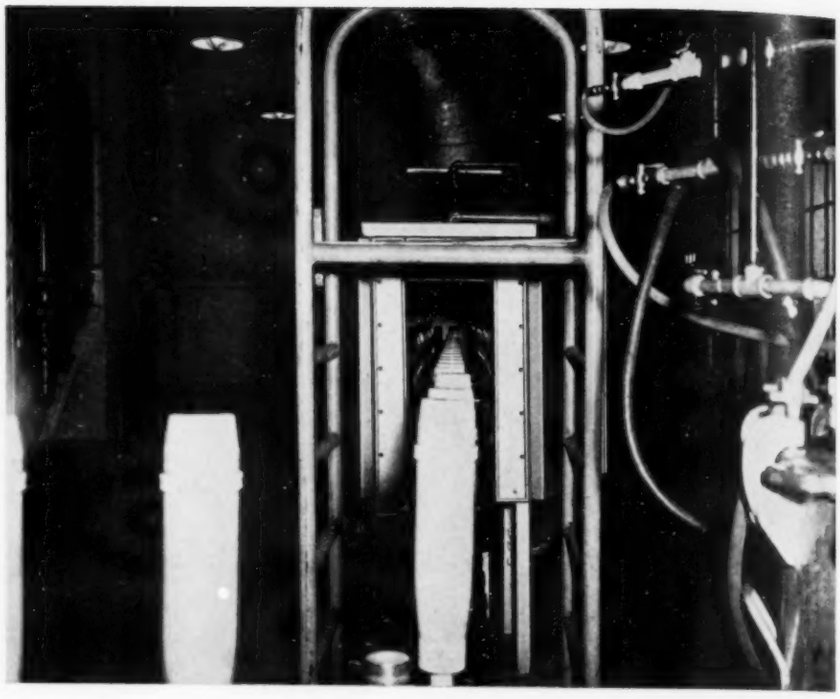


Fig. 3. View inside of infra-red radiant energy tunnel showing arrangement of lamps at right angles to the long axes of the shells. This is graphically shown in Figure 4.

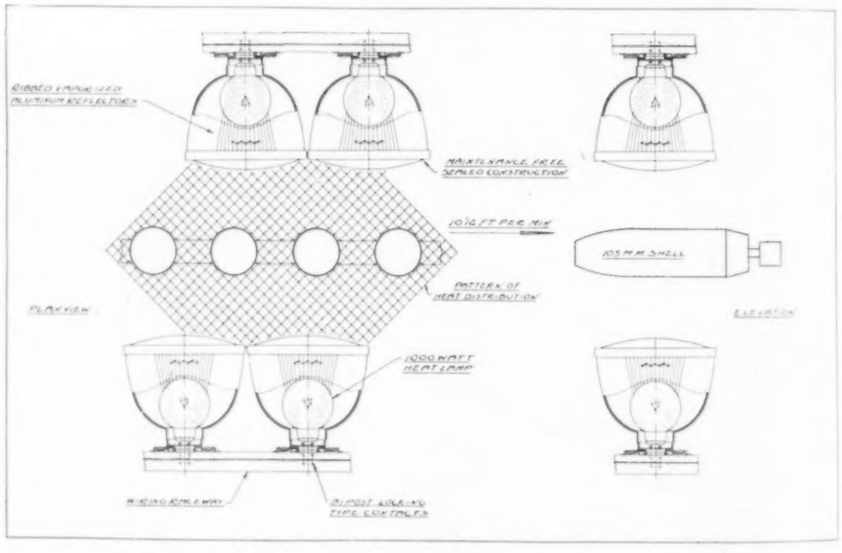


Fig. 4. Drawing illustrating the salient features of the Thermalamp ovens.

Each spray station is equipped with two air transformers, which have a total rated capacity in excess of 100 C.F.M. They incorporate improved metal filtering units which do not need replacement, and are fitted with completely automatic oil and water drains. The lacquer enamel is supplied to the guns from 30 gallon pressure feed tanks. These tanks are mounted on trucks with spark proof casters so that an empty tank can be rolled away and a full one set in its place with the minimum of delay. For that reason each spray station is fitted with a double set of fluid connections so that pressure feed tanks can be shifted without stopping operation. There is a double set of tanks for each machine and each has an air motor driven agitator. As the freshly painted shells leave the spray stations, they pass into radiant heat drying tunnels.

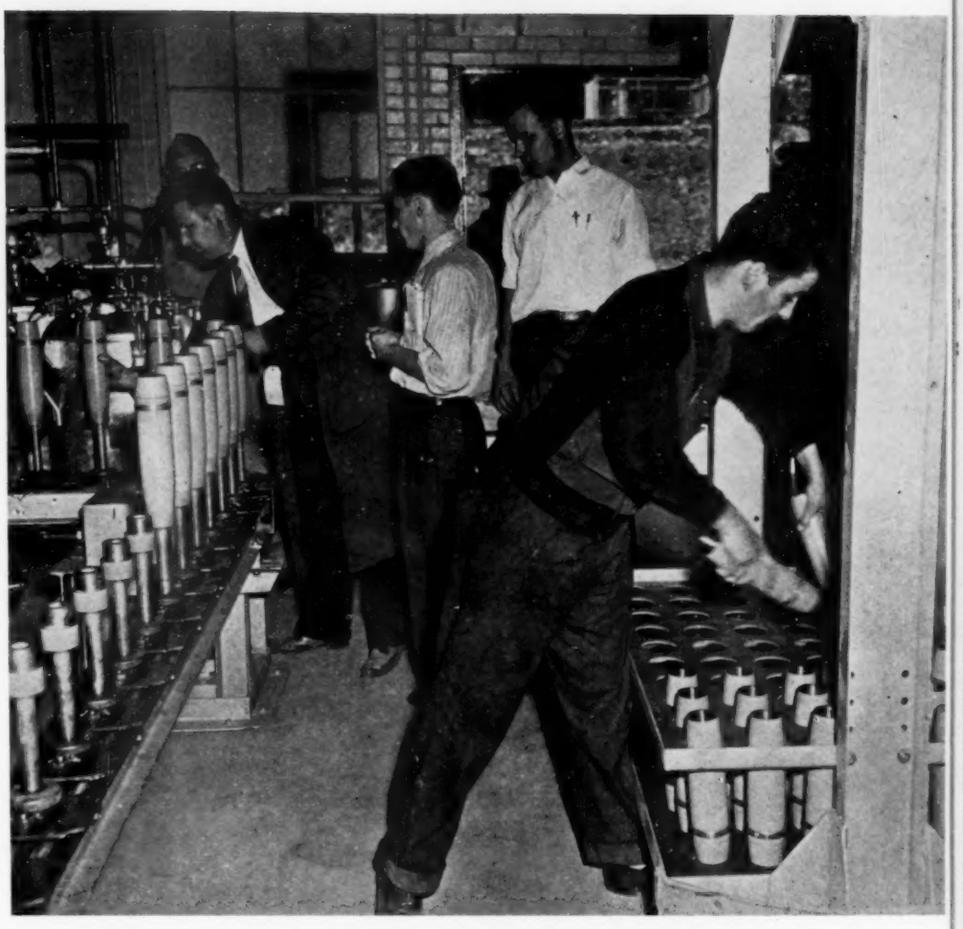


Fig. 5. Workmen unloading finished shells which have just come out of the infra-red radiant energy drying tunnel. Note that the shells are sufficiently cool so that they can be handled with bare hands. A transport rack is shown on the right.

DRYING

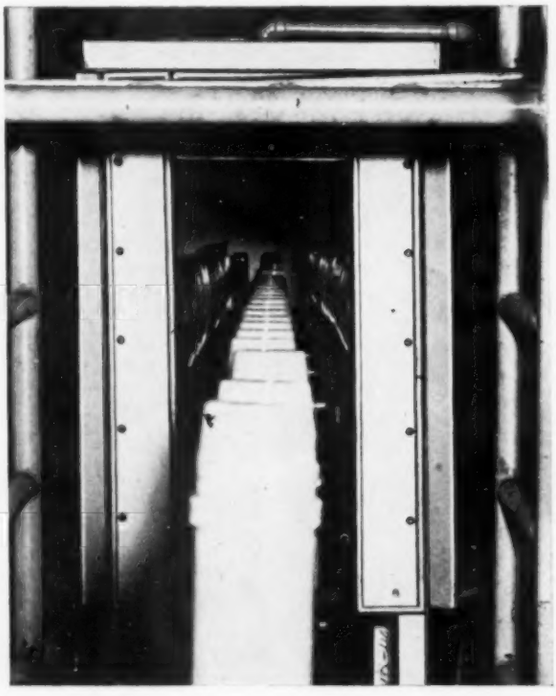
Since the finishing equipment was designed to handle sizes of shells up to and including 105 millimeters, this capacity represents approximately 2½ tons of shells per hour being finished by the two machines. The time cycle in the oven is 3½ minutes and each oven has a heat capacity of 64 kilowatts. A basic feature of the design of the drying tunnels is the Thermalamp three dimensional optical system, illustrated in Figure 4. This differs from a parabolic, spherical or elliptical design in that the fixed angle of energy distribution (determined by the ribbed reflector construction) assures equal delivery of heat to all surfaces of the shells, regardless of whether they are perpendicular or parallel to the axis of the lamps. The shells are slowly rotated as they pass through the drying tunnel to insure complete removal of solvents. Another important feature is the bipost electrical construction providing all locking type connections and eliminating the characteristic screw base of lighting service lamps, which because of temperature and humidity in heating service, application has been found unsatisfactory.

Each tunnel has sixty-four 1000 watt sealed lamp units. C. M. Hall Lamp Company formerly used gold reflectors but the depreciation of the gold reflecting surface, partly by diffusion of the gold into the base metal, resulted in a limitation of effective service life of from 1½ to 2 years. The gold type of reflecting surface has been superseded by the use of a new type reflector similar to that employed on telescope mirrors. It is actually vaporized aluminum on a drawn brass shell. Not only is the initial efficiency superior to gold, but service tests have revealed it to be one of the most permanent type reflectors that it is possible to make. In combination with the sealed lens construction, the characteristic maintenance of lamps and reflectors, due to fogging from paint fumes, is entirely eliminated.

Forty-four feet is the approximate length of each drying tunnel. Both are mounted on structural steel frames which are entirely independent of the conveyor frame. Several doors, located in each tunnel, provide easy accessibility to the lamp banks which may be adjusted, etc., without affecting the machine proper. Since the conveyor length of each machine is approximately 85 feet and the tunnel length is only 44 feet, it was possible to so locate the unloading station that the conveyor length from the tunnel exit to that station was sufficient to provide for proper cooling of the shells.

EXHAUST EQUIPMENT

Overspray from each spray station is exhausted through special water-wash spray booths with elevated wet section. The elevated wet section is a comparatively recent development and gives the advantage of a completely washed down rear panel without the necessity for installing overflow troughs and extra metal curtains, as is necessary in water-wash booths of the conventional type. The exhaust stack of each spray booth contains a 24-inch fan. Each fan displaces 4300 C.F.M. at ¾ inch static pressure, thus providing an air velocity of approximately 240 to 250 lineal feet per minute at the front opening of the spray booths. The fumes released in the drying tunnels are exhausted through four stacks. Fans are provided to assure the con-



The **RAVENNA**

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Shell Finishing Oven

(For Details See Story Page 584)

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sistent removal of vapors regardless of outdoor wind conditions which at times might offset normally adequate stack pressure.

Other Equipment

Special workholders are used to hold the shells on the spindles. The shells are carried nose-end down in such a manner that the workholders act as shields for the fuse threads. Eight hundred and eighty of these workholders were required.

The DeVilbiss Company also supplied band shields or masks. These are made in such a way that, when dropped over the end of the shell, they cling to the rifling bands, thus keeping these precisely machined parts free from paint.

Each spray station is supplied with an explosion proof lighting fixture so mounted that the entire spray operation is clearly illuminated. Compressed air for both automatic machines is supplied by two 15 H.P. water-cooled air compressors.

Lines 2 and 3

Load lines No. 2 and No. 3 handle separate loading ammunition, also 20 to 2000 lb. bombs. All spraying on bombs is done by hand. Eight DeVilbiss water-wash exhaust booths, each 10 feet wide, are used for this hand spraying. The bombs are moved through the booths in groups on carrier frames hung from monorail conveyors. Each booth accommodates two operators and is supplied with two complete sets of spray equipment, including heavy duty production-type spray guns, air transformers, hose cleaners, 30-gallon pressure feed tanks and so forth.

The air transformers are the same advanced type which are installed on the automatic machines mentioned in the foregoing and the guns are the latest removable-spray-head models with spray width and fluid flow adjustments. Each booth has adjustable opening silhouettes through which these bombs pass. These can be changed in size to accommodate the various classifications of bombs. The booths also have the same construction features as the automatic machine booths, except that the water tanks are below the floor and are made of concrete.

There are three mixing rooms, one for each load line. Two mixing tanks, with a total capacity of 240 gallons and mounted on heavy structural steel frames, are installed in each room. The agitator in each tank is driven by a shaft geared to an explosion proof motor which is located outside of the mixing room. Draw-off valves are installed in a manner to facilitate easy filling of the pressure feed paint tanks. The heating, input air, and air conditioning equipment in each room in which spray painting takes place, have been balanced to the exhaust rate of the DeVilbiss booths therein. It is important to note that all paint overspray is exhausted through water-wash chambers. Thus, the possibility of fire in the stacks is definitely avoided, for the water-wash effectively prevents the accumulation of paint with its ever present danger of combustion. It also keeps the outside of the building from being discolored by the precipitation of paint particles.

Acknowledgement is gratefully given to Mr. Ed. Bucy, Zapon Division, Atlas Powder Co., Stamford Conn., Mr. B. C. Gardner, The DeVilbiss Co., Toledo, Ohio, Mr. Paul H. Goodell, C. M. Hall Lamp Co., Detroit, Mich., Messrs. W. E. Fletcher and D. D. Huyett of Atlas Powder Co., Ravenna, Ohio and to Capt. Payne and other Army officials at Ravenna for their assistance in preparing this story and particularly to Lt. Col. R. S. Chavin and Mr. Fletcher for permission to publish this story.

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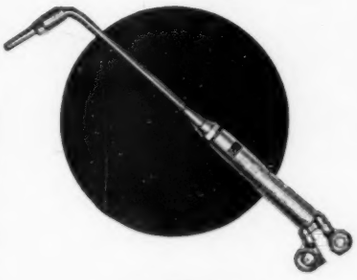

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Shop Problems

Determining Shellac Content

Question. We have on hand a volume of shellac solution of unknown cut. Unfortunately the drums containing this shellac are unmarked and our records give no clues. Will you please advise us of a method of determining the shellac content of this solution.

Answer. You may determine the cut of an unknown shellac solution by the following method, using a weighing bottle, a drying oven and a weighing balance.

Accurately weigh out a small sample of the shellac solution into a clean, dry weighing bottle whose weight has been determined previously. Evaporate the solution to dryness in an oven operating at approximately 100° F. and weigh again. Calculate the per cent of dry shellac in the solution by dividing the weight of the dried sample by the weight of the wet sample and multiplying by 100. The approximate cut corresponding to the percentage may then be read from the following table. Interpolation may be necessary.

% Dry Shellac	Cut
12.9	1.0
18.0	1.5
22.8	2.0
26.9	2.5
30.6	3.0
33.8	3.5
37.0	4.0
39.7	4.5
42.4	5.0
44.6	5.5
46.9	6.0

Cost of Hot Lacquer

Question. In our investigation of the possibility of using lacquers applied at elevated temperatures, we have found that the cost per gallon of lacquers formulated for such application is somewhat more than proportionally higher that would be expected for the higher solids content and lower solvent content. Can you account for this? We feel that the answer is in the solvent content of these high solids lacquers but we do not know just how it is explained.

Answer. You are correct in your assumption that the reason for the higher than proportional cost of the so-called hot lacquers over the conventional type lies in the solvent content. In general, richer and higher boiling solvents must be used in the formulation of lacquers designed for application at elevated temperatures. The reasons for this are twofold. First, because of the temperatures used, there is an increase in evaporation and low boiling solvents which would be lost rapidly and thus affect flow adversely, must be replaced by higher boiling solvents. Secondly, and also because of the temperatures used, there is a reduction of the tolerance of the solvent mixture for nitrocellulose and some of the diluents must be replaced by actual solvents.

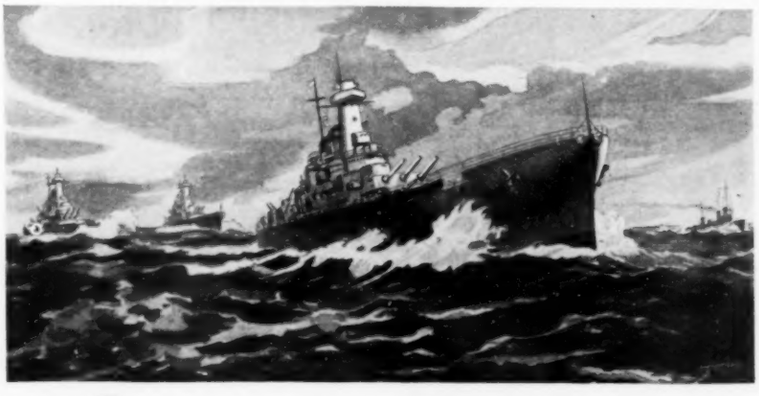
It must be remembered, however, that while the cost of the solvent mixtures used in hot lacquers is higher, the amount of solvent per pound of solids is very much less and there is an overall savings. Material cost calculations should not be made on a per gallon basis, but rather on a per pound of solids or on a per unit area finished basis.

Vitreous Enamel

U. S. Pat. 2,252,588 R. J. Whitesell, assignor to Röhm & Haas Co., August 12, 1941. An opacifier for vitreous enamel consisting of 7 to 15 per cent zirconium silicate and 0.25 to 4 per cent aluminum phosphate in the frit.

Metal Spray Gun

U. S. Pat. 2,252,942 C. M. Mourer, August 19, 1941. A metal spray gun of improved design, with means for feeding, melting and spraying metals.



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TESTS ON SOLVENTS

By James G. Shelton

New York

FROM the standpoint of application —spraying, dipping, roller coating and the like—the solvents are probably the most important part of an organic finishing material. Solvents are often taken for granted, at least until troubles appear in the form of sags, pinholes, poor coverage on sharp edges or any one of a number of other difficulties which may arise in whole or in part from solvents. It is only then that attention is given to solvents and that the important role which they play is appreciated.

The fact that the solvents in or added to a finishing material can usually be taken for granted by the user is only so because there has been considerable testing done to determine their suitability. It is the purpose of this discussion to acquaint the user of finishing materials with some of the tests to which solvents are submitted—by producers of solvents and by manufacturers of finishing materials—in order that the best ones may be selected to fit the particular requirements of the user.

Given below are some of the more widely used tests for solvents. No attempt has been made to give complete or working details. Rather, general procedures are covered in order that, within a limited space, information on the more important solvent tests may be presented.

Distillation

The distillation test is one of the most important and significant physical tests applied to volatile organic solvents. It is used for checking purity (in general, the purer the solvent, the more narrow the boiling range). Also, valuable information on the volatility, etc. of the solvent may be obtained from the test data.

The test is carried out by distilling a given volume of solvent under specified conditions and in apparatus of standard design.[1] The temperatures at which the first drop and last drop of solvent come from the condenser are recorded. Between these two points, the temperatures at which 10, 20, 30, etc. per cent have distilled over are recorded, or, the volumes which have distilled over at intervals of 10°C. between the lowest and highest temperatures are recorded. From these data a very useful temperature distillation curve may be drawn.

In the test, attention is also given to any material which does not distill and which remains in the distillation flask. Such residue is termed the distillation loss and represents the difference between the amount of solvent with which the test was begun and the amount of solvent distilled over.

While the boiling points of solvents of the same general class of chemical compounds indicate relative rates of evaporation, it does not follow that information on evaporation rates may always be deduced from boiling points. Therefore, when data on the evaporation rate of a solvent are desired, it becomes necessary to make an individual test. Unfortunately, because of many complicating factors, results from evaporation rate tests are not absolute (such as in the case of the determination of boiling points), that is, it is difficult to deduce results with any degree of accuracy. The usual procedure involves performing the test on the solvent under consideration and at the same time on some solvent chosen as standard so that the results may be expressed relatively. A given weight (or volume) of the solvent is allowed to evaporate. At intervals, note is made of the amount lost to the air. In some instances a fan is employed to hasten evaporation. In any event, careful investigators record such information as temperature of the air, humidity, area of surface exposed and any other data which might be useful in evaluating the results.

Non-Volatile Matter

In many instances, the presence of non-volatile matter, suspended dirt, etc. is undesirable in solvents. Consequently, some specifications for solvents include limits on the amount of such non-volatile matter. The test is made by evaporating a carefully measured amount of the solvent (either by volume or by weight) almost to dryness on a steam bath. The sample is then dried to constant weight in an oven operating at approximately 220° F. Results may be expressed as the weight of non-volatile matter per unit volume of solvent or as a weight percentage calculated from the weight of the original sample.

Specific Gravity

The specific gravity of solvents is of interest in connection with shipping weights, cost calculations, volume corrections, etc. To a lesser extent it is of importance for checking purity, although specific gravity data on mixtures of solvents are not entirely indications of purity. Determination of the specific gravity of solvents, however, is often a routine test, an hydrometer, pycnometer or Westphal balance being used. Water, at some standard reference temperature, is taken as the reference liquid.

Residual Odor

For certain uses, solvents should evaporate cleanly and quickly, that is, there should be no materials present in the solvent which remain after the bulk of the solvent has evaporated, particularly if these residual materials have any objectionable odor. It is possible to obtain information on residual odors by dipping a piece of clean heavy filter paper in the solvent under consideration, hanging up the paper to dry and smelling the paper as evaporation progresses. The presence of residual odors is quickly ascertained by this method.

Water

The presence of water in a solvent

is often undesirable since blushing and other conditions may result. The test for water in a solvent is as follows. A small accurately measured volume of the solvent in question is placed in a glass container fitted with a glass stopper. Small amounts of 60° Baume gasoline are then added, with shaking after each addition, until turbidity develops. Results may be reported as the volume of 60° Baume gasoline required per unit volume of solvent to produce turbidity.

Water Solubility

This test, somewhat similar to the one above, is performed to determine the maximum amount of water which a given volume of solvent will dissolve. A carefully measured volume is placed in a convenient glass container. Small amounts of water are added, the container being shaken after each addition, until turbidity develops. The test is usually made at some standard reference temperature and results are usually expressed in weight per cent of water added.

Acidity

Because of possible deleterious effects on resins, pigments, etc. and further because containers, equipment, etc. may be corroded, considerable attention is paid to the acidity of organic solvents. The method used is a volumetric one. A carefully measured volume of solvent is placed in a suitable glass container and is titrated with a standard solution of alcoholic potassium or sodium hydroxide. Phenolphthalein is used as an indicator. Results are expressed as the weight of alkali per unit weight of solvent required to effect neutralization. Results may also be calculated on the basis of weight percentage of acid present in the solvent.

Alkalinity

For the same reasons stated under the Acidity Test, solvents are tested for alkalinity. The procedure is much the same as that given above, except that a standard acid is used with methyl orange as the indicator. Results are expressed as the weight of acid per unit weight of solvent required to effect the neutralization or on the basis of weight percentage of alkali present in the solvent.

Dilution Ratio

In the manufacture of lacquers it is almost a universal practice to use some volatile organic fluids (called diluents) which are not true solvents for nitrocellulose. It is important, therefore, that a knowledge be had of how much of a particular diluent can be tolerated by a solution of nitrocellulose without precipitation. Such information is obtained by means of the dilution ratio test. A solution of nitrocellulose of standard concentration is used. To this the diluent is slowly added until precipitation of the nitrocellulose just barely occurs. The dilution ratio is obtained by dividing the volume of diluent used by the volume of true solvent used in the original solution.

Kauri Butanol Number

This is a test somewhat similar to the dilution ratio test and is useful as an index of the tolerance of a resin solution for certain types of diluents. A standard solution of kauri gum in butanol (normal butyl alcohol) is used. The diluent is added, as in the case of the dilution ratio test, until precipitation (cloudiness) appears. Results are reported as the volume of diluent added to the quantity of kauri gum solution used for the test.

Sulphur

Because darkening may result from the use of solvents containing sulphur, solvents are tested with lead acetate and starch iodate indicating papers. Discoloration of the lead acetate paper indicates the presence of hydrogen sulphide, while the appearance of a blue color on the starch iodate paper shows the presence of sulphur dioxide.

Flash Point

Whenever volatile organic solvents are used, there is the danger of fire and explosion. Valuable information on this may be obtained from the flash point test. In this test either an open cup (Cleveland type) or closed cup (Tag type) may be used. The solvent is placed in the cup and is gradually heated. At suitable intervals of temperature, a small flame is thrust into the vapor above the cup. The temperature of the solvent at which the vapor over the solvent flash is known as the flash point.[2]

There are, of course, a number of tests for solvents in addition to those discussed above. For more complete details on the tests given here or for information on tests not considered certain texts published by both individuals and manufacturers of finishing materials and solvents may be consulted.

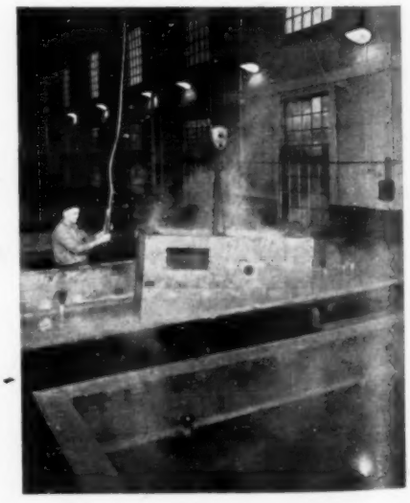
1. The American Society for Testing Materials has prepared a very complete procedure for the distillation of petroleum products (naphtha, kerosene, etc.). This procedure finds wide use.

2. The American Society for Testing Materials has also written complete details of the operation of both the Cleveland open cup method and the Tag closed cup method.

Bonderizing Large Metal Enclosures Reduces Handling

Facilities to bonderize large metal enclosures for switchgear and electrical control have recently been put into service at the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company. Result is a reduction in handling of these units and a large saving in time required for the bonderizing process.

Formerly the enclosures had to be bonderized in sections and then welded together. The welding operation destroyed the bonderized surface making a very unsatisfactory paint base. Reversing the sequence has eliminated this undesirable feature and has also saved much time and handling in the manufacture of these units.



Metal tank being withdrawn from Bonderizing solution after treatment.

News In Industry

A. F. Von Hirsch Joins Kirker Chemical Corporation

A. F. Von Hirsch has become sales manager of the Industrial Division of the *Kirker Chemical Corporation*, Paterson, N. J. This company manufactures all types of clear and pigmented lacquers as well as synthetic enamels. Mr. Von Hirsch was employed with Maas & Waldstein Company, Newark, N. J., for twenty years and much of this time was spent in the Metropolitan area of New York.

He is a member of the Newark Branch of the American Electroplaters' Society.

A. F. Von Hirsch

Devoe & Raynolds Co., Inc., 787 First Ave., New York, N. Y., have announced the appointment of *Milton W. Lightcap* as sales manager of the newly created Painter and Maintenance Division.

The announcement was made by *W. H. Mathews*, vice-president, who indicated the move was made in order to coordinate activities of these two important and previously separate departments. Mr. Lightcap, formerly head of Pittsburgh Plate Glass Company's maintenance division, has been with Devoe just over a year.

New Plant to Manufacture Rosin Esters

A new plant for the production of rosin esters at Hattiesburg, Miss., will go into operation early in October, Hercules Powder Company, Wilmington, Delaware, have announced. Construction of the new plant, begun in June, has been speeded to meet the growing demands of the National Defense Program.

The new unit which adjoins the Hercules naval stores plant at Hattiesburg will increase the company's rosin ester productive capacity 60%.

Construction also will begin immediately at Hattiesburg of an additional unit for which appropriations have been made even before the first new unit was completed.

Demand for the rosin esters, Abalyn, methyl abietate; Hercolyn, hydrogenated methyl abietate; Flexalyn, diethylene glycol diabietate; Pentalyn, pentaerythritol tetraabietate; Staybelite, hydrogenated rosin and Staybelite ester gums; has increased so rapidly during 1941 that sharp expansion of manufacturing facilities was required. Stimulated by price reductions announced last January for all of the rosin esters, existing fields for these products have been expanded and new uses developed.

Coating Composition

U. S. Pat. 2,252,485 C. M. Hull, assignor to Standard Oil Company, August 12, 1941. A coating composition consisting of about 90% chlorinated isobutylene polymers containing about 50% chlorine and about 10% of chlorinated paraffin wax containing about 30% chlorine.

Phosphate Coatings

U. S. Pat. 2,245,609 G. C. Romig, assignor to American Chemical Paint Co., June 17, 1941. A method of finishing ferrous metals by coating with a water insoluble metallic phosphate by treating it with an acid zinc phosphate solution containing hydrogen peroxide and following by a chromic acid dip containing ½ to 8 lbs. of chromic acid per 100 gallons of solution, preferably 4 lbs. per 100 gallons. This minimizes paint blistering on the surface.

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NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Safe Lighting of Deep Paint Spray Booth

Holophane Co., Inc., New York, N. Y., were faced with the problem of safely illuminating deep spray booths for painting airplane wings, 35 and 40 feet from entrance to water wash at the back. The air was being moved back of the booth at the rate of 100 ft. per minute.

The explosive nature of solvents necessitated that lights and wiring be protected from vapors. The former method employed introduced light from vapor proof fixtures located outside of the booth through wire glass windows. Fourteen 200 watt units in a booth 35 ft. deep gave 10 footcandles of light on the airplane wings. It was realized by Holophane Company engineers that too much glass was used in the old method, thus absorbing part of the light. In addition, maintenance was not easy and the wire glass had a tendency to crack when washed. The company installed new style prismatic reflectors for the window to provide illumination of the vertical wing surfaces. The box units now contain 200 watt lamp and reflector, the unit being served by an air line as well as electricity. One pound of air pressure keeps the fixture from any contact with paint vapors. Lights are interlocked with the air compressor and hence if there is no air, there is no light or vice versa. A mercury switch will turn off any light when enclosing box cover is lifted.

View of recessed part of lighting unit.

By this new installation, the company claims to have eliminated danger of explosion and to have raised the footcandle illumination at the plane wing surface to 37 as compared with 10 for the older system.

Further details can be obtained from the Holophane Co., Inc., Dept. CSB, 342 Madison Ave., New York, N. Y.

New Protective Hand Cream

Mitts Mfg. Co., 367 E. 45th St., Brooklyn, N. Y., have announced the development of a new protective hand cream called "Mitts".

This material is stated to be a water soluble hand cream that is applied to the skin before starting work. It dries quickly and is claimed to act as an invisible glove, guarding the hands from grease, paint, ink and other matter difficult to clean.

PROTECT YOUR HANDS
with
MITTS
Prevents Skin From Absorbing Paint, Ink, Grease, and Other Matter Difficult To Clean
MITTS MFG. CO.
Brooklyn, N. Y.

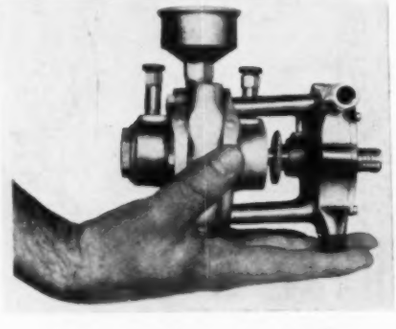
Protective hand cream.

In addition, it is also stated that the material protects the hands from many irritating substances which frequently cause industrial dermatitis. The hand cream washes off easily with soap and water, taking all dirt with it.

New Midget Size Air Powered Pump

The Eastern Engineering Co., 45 Fox St., New Haven, Conn., have announced the addition of a new model midget size pump to their line called "Eastern Model D Air Powered Pump". It is claimed that the air powered motor makes it positively explosion-proof and variable performance can be obtained by variation in the speed of the air motor. It weighs 10 lb. and consumes 5 cu. ft. per minute of air at a maximum speed of 4000 R.P.M. on 100 lb. maximum air pressure. When operating on 100 lb. air pressure, the maximum capacity of the pump is 15 gal./min. and maximum pressure developed is 34 lb./in.^{2} On 50 lb. air pressure, the maximum capacity is 12 gal./min., with maximum pressure of 24 lb./in.^{2} On 20 lb. air pressure, the maximum capacity is 7½ gal./min., with maximum pressure of 13 lb./in.^{2}

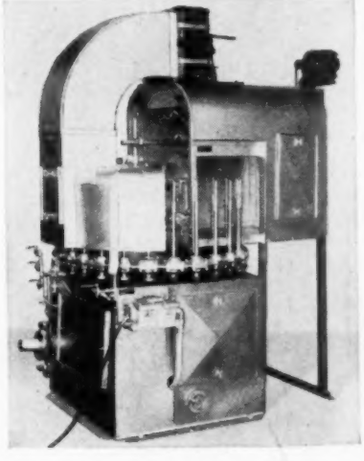
Pumps are available in various corrosion resistant alloys.



Midget size air powered pump.

Small Shell Sprayer

An automatic spray machine to coat and dry the outside of small shells (20 - 40 mm.), grenades, shot, or boosters, has been built by the Eclipse Air Brush Co., 400 Park Ave., Newark, N. J.



Small shell sprayer.

The machine consists of an automatic turntable on which the pieces are carried on indexed spindles to a position in front of automatic spray guns in a booth equipped with exhaust fan. After being coated, the pieces go through a small oven opposite the spray booth. A unit heater with blower fan insures rapid drying so that the pieces can be removed manually as they emerge from the oven.

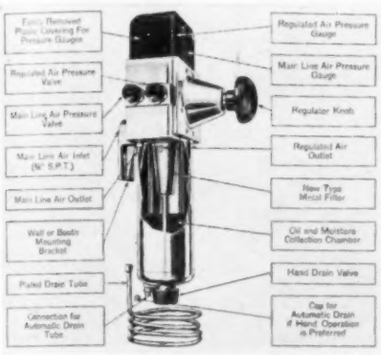
The whole unit is very compact, taking a floor space of only 4′ x 4′, and working parts are enclosed wherever possible to keep down maintenance costs.

New Large Capacity Oil & Water Extractor

Binks Manufacturing Company, 3114-40 Carroll Ave., Chicago have just announced the marketing of a New Large Capacity Oil & Water Extractor, known as BINKS E-75.

This new extractor has a rated capacity of 75 c.f.m., at 60-70 lbs. pressure, and has two main line air outlets, as well as two regulated air outlets.

Designed to meet the needs of a larger capacity extractor, and ample to handle the air needs of several modern spray guns at low or high pressure, the New E-75 incorporates all the latest features of modern streamlined designing.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Main Line Air Pressure Gauge
Regulator Knob
Regulated Air Outlet
New Type Metal Filter
Oil and Moisture Collection Chamber
Hand Drain Valve
Cap for Automatic Drain if Hand Operation is Preferred

Large capacity oil and water extractor.

In this new extractor the Binks Manufacturing Company have incorporated a new air cleaning principle with a highly efficient metal filter, which thoroughly cleans, but does not impair the free flow of air.

Another outstanding feature claimed is the achievement of a more uniform air pressure, due to a new designed and improved large capacity air regulator, which is part of the unit.

The enclosed diagrammatic photograph shows other interesting details on the construction of this extractor.

Inside Silvered Lamps for Radiant Energy Heating

North American Electric Lamp Co., 1043a Tyler St., St. Louis, Mo., have developed inside-silvered carbon filament lamps for infra-red radiant energy for drying, baking, heating and dehydrating.

The pure polished silver in the base of the lamp acts as a reflector to project the infra-red rays toward the surface being heated. These lamps are of the carbon filament type, such as have been used in many automobile factories for drying the original paint finish.

Inside silvered lamps for radiant energy heating.

The manufacturer claims that the wavelength emanations of the heat from these lamps are in the more desirable range of heat energy for maximum drying efficiency. Inside-silvered lamps are available in the Model R-40 with a rating of 250 watts, 110-120 volts.

Lower priced clear glass infra-red lamps are also available in two different models. The clear glass types require separate reflectors, which the manufacturer can furnish either of the gold plated or aluminum types.

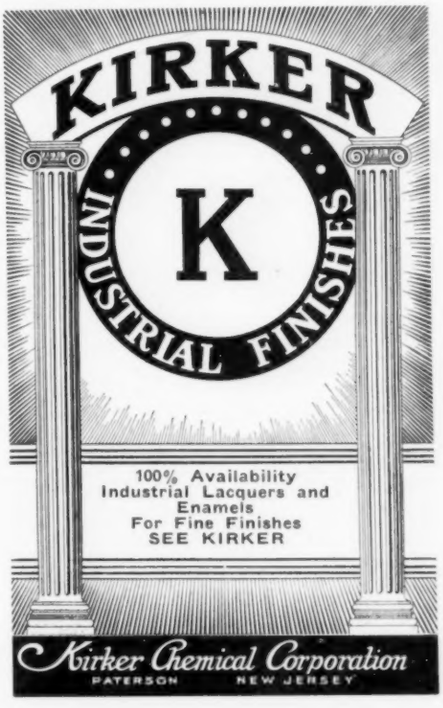
Bulletin No. A-58 of the company describes these lamps.

Concrete Floor Enamel

The Wilbur & Williams Co., Park Square Bldg., Boston, Mass., have announced the development of a special stain and enamel for concrete floors.

The finishing of the floor first involves a staining of the concrete, and following this, a synthetic enamel is applied which is stated to adhere solidly to the stained concrete. This enamel is reported to be not affected by moisture or lime, and is said to be resistant to alcohol, gasoline and many other chemicals. The first application is a flat finish and the top coating is a gloss.

The combination of enamel and stain is reported to assure a very long life of the color. The finishes can be obtained in four colors: tile red, battleship grey, club green and chestnut brown.



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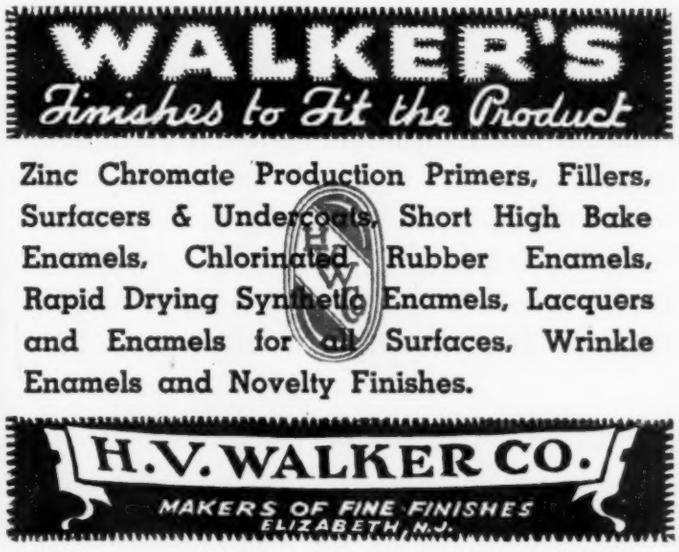
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Color System for Machinery Painting

A new color system for painting machinery which reduces eye fatigue and promises to increase production was reported at the Atlanta meeting of the Illuminating Engineering Society on September 25.

Arthur A. Brainerd, of the Philadelphia Electric Company, and Matt Denning, of the Finishes Division of the Du Pont Company, gave collaborative findings of a two-year investigation into "Improved Vision in Machine Tool Operators by Color Contrast", which they said developed surprising results.

Studies of how brightness and contrast in paint colors on machinery combined to increase the accuracy of seeing, thus reducing accident hazards, providing more comfortable working conditions, and also increasing production were presented in a color motion picture.

Many colors possessing higher light-reflecting factors than the conventional dark green or battleship gray of machine tools were tested under actual plant conditions, it was explained. Aluminum, light gray, light green, light blue, yellow, and light buff coats were applied in turn to a punch press and a power shear over periods of two weeks. Photometric readings were recorded of light falling on and reflected from working surfaces while time studies were made of production rates. Separate records were kept of the research under both incandescent and mercury lighting.

The psychological effect upon the operators, consisting of 15 men, including two foremen, was determined by a simple questionnaire. Results of the brightness measurements, the time studies and the questionnaire were correlated.

Ratings on the basis of 100 showed light buff and light gray with the highest scores, aluminum standing very high and light blue showing promise.

In order to render the results practical from a maintenance standpoint, a compromise was made by painting all machines in "Horizon Gray" and "spotlighting" the working area with light buff. Surprisingly, the combination seemed to perform better than any of the solid colors.

Portable Spray Painting Outfits

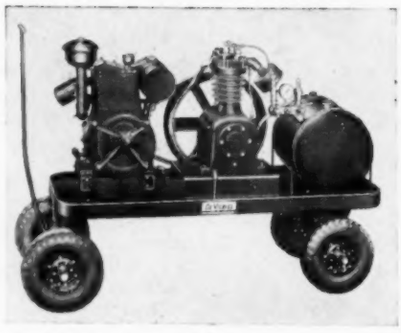
Two greatly improved series of four and six horse power portable spray painting air compressing outfits, for operation of two and three spray guns, have just been released by the DeVilbiss Co.

The outfits are ideal for larger installations: in industrial and maintenance work, highway departments, public works, oil fields, mines, public buildings and the like.

Twenty assemblies are included in the two series—skid-mounted outfits, rubber-tired and steel wheeled trucks, and two wheeled trailers.

The six horse power units may be had with or without an electric starter, and air or water-cooled engines are optional with this series.

All six horse power units have twin disc clutch as standard equipment. This permits starting of the engine independently of the compressor.



4 H.P. gasoline engine driven portable air compressing outfit.

Spray painting equipment for use with the outfits has been set up to be purchased separately from the air compressing outfits. Two-gun equipment is designated as type QM-6016. It may be used with any of the four or six horse power compressing outfits. Three-gun equipment, for use with the six horse power units, is designated as type QM-6017.

Complete information regarding the new DeVilbiss TS and TD (4 h.p.) and TNS and TN (6 h.p.) spray painting air compressing outfits may be had from DeVilbiss jobbers, or direct from the DeVilbiss Company, 300 Phillips Ave., Toledo, Ohio.

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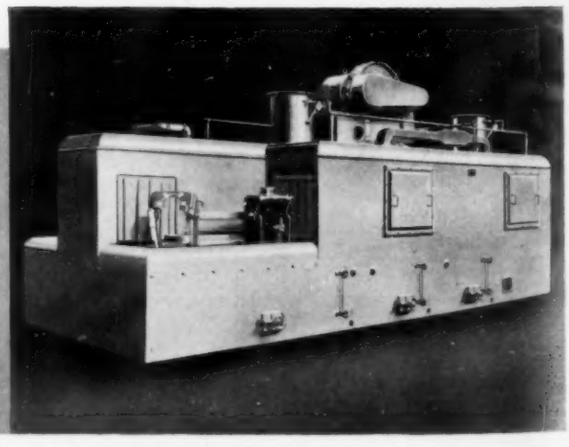

Right: Multi-stage spray washer with special tilting fixtures on conveyor. Used in the cleaning of Aircraft engine cylinders.

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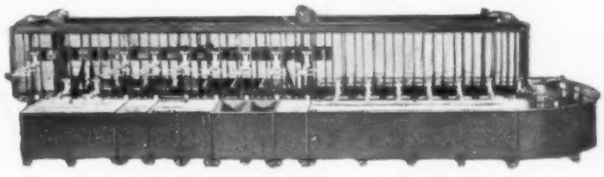

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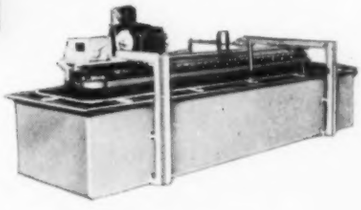

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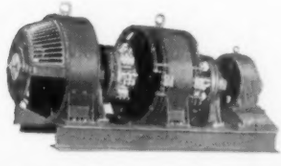

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Drastic Restrictions on Copper

The effects of OPM Order No. M-9-c curtailing the use of copper will be far reaching and will be a serious blow to the non-defense portion of the metal working field. The reasons for the order are apparent after examining supply and demand figures for copper. Estimates for 1942 indicate a supply of 1,650,000 tons which includes 600,000 tons of imported ores subject to shipping hazards. The demands for defense are estimated at 1,050,000 tons, for essential civilian requirements (e.g. power lines, transportation) 250,000 tons, and for other civilian use 1,100,000 tons, making a total estimated demand of 2,400,000 tons or an indicated shortage of 750,000 tons. Principal demands for copper in defense are for shell casings, wire and cable and maritime uses.

The use of copper in more than a hundred civilian types of articles is restricted to approximately 60 per cent of a 1940 base period, until Jan. 1, 1942. The use of copper in the manufacture of the articles listed is prohibited after Jan. 1, 1942, except for non-decorative plating. Use of copper in building construction is prohibited after Nov. 1, 1941. The use of copper in all items not listed is reduced to 70 per cent of a 1940 base period.

The exception regarding copper for non-decorative plating may cause considerable confusion in the plating industry and will have to be clarified. Obviously, copper plating may be decorative and still be for corrosion protection or other purposes. Copper as an underplate for nickel is certainly non-decorative and yet the composite coating may be both protective and decorative. Non-decorative plating would be that, for example, used as a stop-off in selective carburizing. Exceptions are provided in the restrictions to insure general welfare and for uses in which copper is hard to displace. These include, for example, uses in research laboratories, chemical plants, public steam generating plants and public vehicles.

An examination of the list of materials in the making of which copper is prohibited will quickly show the far reaching import of the order. It excludes practically all bright work and accessories for automobiles, such as heaters, horns, mirrors, headlamps, moldings, general hardware and garage and automotive repair equipment. The building supplies and hardware industry is particularly hard hit because copper was an important component of many of the products made by this branch of the industry. Included among the restrictions in this category are: door knockers, door checks, lighting fixtures, push, kick, switch and floor plates; grilles, screening, ventilators, and general builders' hardware. Restrictions are applied to equipment used in building homes, such as roofing, flashing, ventilators and weather stripping.

Restrictions are almost complete on burial equipment and thus the use of copper is restricted in making burial vaults, casket hardware, caskets, memorial tablets and morticians' supplies.

The dress accessory field restrictions will particularly affect New England industry. The use of copper is restricted in making such articles as buckles, buttons, dress ornaments, handbag fittings and metal cloths. Copper is widely restricted in articles for house furnishing and in office equipment. These include andirons, cooking and table utensils, furniture, household appliances, such as, fans, heaters, stoves and ranges, lamps, vases, bowls and general artcraft.

Another class of article in which the use of copper is restricted and which will particularly affect New England, is that embracing jewelry, gifts and novelties. This class also includes advertising specialties, cosmetic containers, cigarette lighters, smokers' accessories and souvenirs.

An examination of the items grouped under the miscellaneous classification leads one to wonder whether any items remain unrestricted. Under this classification is included all plating primarly for decorative purposes, bicycles, motorcycles, chimes and bells, fire extinguishers, keys and locks, luggage fittings, nameplates, radios, stationery supplies and toys. None of these lists is given here complete and the original order should be consulted.

An appeal from this order can be made by anyone who feels compliance would work an unreasonable and exceptional hardship on him or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of copper conserved. Appeal should be made to the Director of Priorities, Ref: M-9-c, Office of Production Management, Social Security Building, Washington, D. C., setting forth the pertinent facts and the reasons he considers he is entitled to relief. The Director of Priorities may thereupon take such action as he deems appropriate.

Defense Highlights

OPM to crack down on priority misuse. According to William P. Homans, coordinator of the priorities field service for the northeastern area, a drive will be made to prevent use of materials, ordered on priorities, for making non-defense goods. A drive is also being made to reduce inventories of stock to a working minimum.

The shortage of scrap iron has become so acute that steel production has taken a downward trend and predictions are that the ingot iron output will drop to 85% of capacity by the end of the year. Completion of projected blast furnaces and Bessemers will help to maintain steel production but no actual steel expansion appears likely.

Glycerin, a vital component of resins and plasticizers for organic finishing materials, was placed under a price ceiling on October 28th. In addition to glycerin, price ceilings have been placed over six other basic chemicals, namely, **formaldehyde, ethyl alcohol, acetic acid, wood alcohol, acetone** and **butanol.**

A Die Casting Defense Industry Advisory Committee was announced on October 23rd. Two members of the committee are well known to the plating industry, namely, Carl Heussner, metallurgical engineer, Chrysler Corp., Detroit, Mich., and D. Basch, metallurgical engineer, General Electric Co., Schenectady, N. Y.

The restrictions on bright work on automobiles in an OPM order of October 27th, will be a serious blow to the plating industry. Donald M. Nelson, director of priorities, decreed that "on and after December 15th, 1941, the use of bright finish, bright work, metal finish, or body trim containing aluminum, copper, nickel or chrome shall be discontinued in the production of new passenger cars, except where special permission is granted for bumpers. There shall be no further production of such bright work, effective immediately, except in amounts necessary to complete passenger automobiles scheduled to be completed before December 15. Permission may be granted to use the restricted materials in the plating of bumpers and bumper guard assemblies, provided evidence is submitted to OPM's Division of Civilian Supply showing that all possible conservation measures have been utilized and that usage will be held to 'minimum practicable quantities'."

The largest civilian consumer of lead is the storage battery industry which in 1939 used 30% of the lead consumed.

Three special exhibit trains painted red, white and blue, will tour the country beginning November 10 to disseminate information to manufacturers on how to get defense contracts. One train will tour the East, another the Midwest and a third, the Far West. Manufacturers may obtain admission to the trains and the dates of visit by writing to the nearest field office of the OPM Contract Distribution Division.

Monthly airplane construction increased from 1016 in January to 1854 in August and 1914 in September.

Three companies making household washers and ironers have been awarded a $12,000,000 contract for anti-aircraft gun mounts. These companies will share the work with other members of the industry under sub-contracts, to help alleviate the conditions caused by curtailing production in washers and ironers.

Tung tree plantings increased from 350,000 in 1930 to almost 13,000,000 in 1940. Increased domestic demands for tung oil for the manufacture of paint, lacquer, varnish and waterproofing materials and drastic curtailment of imports of oil from the Orient, indicate a large tung oil market in the U. S. A few years will be required for the large number of trees, recently planted, to come into production.

Chlorinated solvents including carbon tetrachloride, trichlorethylene, perchlorethylene and ethylene dichloride were placed under a "ladder of uses" control in OPM's General Preference Order No. M-41 issued October 15. These solvents are used extensively in the metal cleaning field. An emergency pool is created which is based on the percentage of the stock after defense requirements have been filled.

Increased prices for zinc are expected to increase zinc production by 10 per cent. The present domestic production is at the rate of 75,000 tons a month.

Used drums are bringing higher prices than new ones. In many cases because of priorities, OPM controls, and shortages, second-hand steel drums are frequently bringing higher prices than new ones delivered direct from steel barrel manufacturers. The reason is largely the availability of the second-hand drums. For example, new drums are being purchased at $2.50 each whereas second-hand drums are frequently bringing $2.75 to $3.00.

SILVER COATINGS ON NON-METALLIC SURFACES †

By J. R. I. Hepburn

INTRODUCTION

A NUMBER of instances of the silvering of glass followed by electrodeposition are known. One such instance is the production of heliograph mirrors, where the Army Specification requires silvering by immersion, followed by copper backing by electrodeposition from the acid copper bath. A second instance is the protection or "armouring" of glass vessels, *e.g.*, soda siphons, by silvering the outside surface, followed by electrodeposition of a heavy copper deposit from the acid copper bath. A third instance, of some interest, is the production of all metal parabolic reflectors for cinema projection apparatus. These are made by the silvering of a glass former or mould, produced to the exact curvature required. A very heavy deposit of copper is formed on the silver deposit, from the acid copper bath. When the deposit of copper is of sufficient thickness, the whole is stripped by force from the glass mould, when it is found that the silver deposit adheres preferentially to the copper, and the mirror, which is of excellent quality, is detached from the glass surface on which it was originally deposited. The silver mirror is subsequently rhodium plated to give the final high non-tarnishable finish required.

While the fact that glass may be silvered by simple immerson is well known, it does not appear to be so generally realized that the process of silvering by immersion can be carried out on non-metallic surfaces other than glass, including mica, celluloid, and plastic materials generally. This fact opens up a range of possibilities in the field of electro-metallizing non-metallic surfaces, as an alternative to the use of graphite or of bronze powder.

It is not suggested that silvering is likely to displace the older methods. Considerations of cost would no doubt play an important part. On the other hand, there may be occasions where silvering as a preliminary to electro-metallizing would offer clear advantages. There are two possible advantages in the use of silvering. The first is that the silver deposit covers the whole of a given surface however intricate the shape, with a film of reasonably uniform thickness, so that electrical contact is established all over the surface to be subsequently electroplated. It is quite conceivable that if the object is of irregular shape, some difficulty might be experienced in insuring good contact all over the surface by graphitizing or by the use of bronze powder. A second advantage is that the extreme, but known, thinness of the silver film (for data on thickness see page 606) makes it possible to use it for the subsequent electrodeposition of other metals in accurately known thickness. Thus, I have deposited cadmium on silvered glass, and on silvered mica, to a thickness of one ten-thousandth of an inch, in connection with work on micro-fuses.

The extremely rapid development of moulded plastics in recent years also suggests more general possibilities in the direction of electro-metallization. Ideas on this subject are, of course, at the moment completely speculative, but it seems of interest to consider possible relative advantages of a metallized moulded plastic as against, say, a plated zinc-base die-casting. No doubt many factors enter into such a comparison, including primarily cost of production, ease of production, mechanical strength of a metallized plastic in relation to thickness of metallic deposit required, saving in metal, comparative lightness, and so on.

FORMULAE AND PRACTICAL METHODS USED IN THE DEPOSITION OF SILVER COATINGS ON NON-METALLIC SURFACES

(i) General

It is interesting to note that the process of immersion silvering of glass was first practiced in or about 1840, the same year that Elkington introduced the electroplating of silver. The actual discovery of immersion silvering was made by Liebig in 1835, who found that by heating aldehyde (*i.e.*, acetaldehyde) with an ammoniacal solution of silver nitrate in a glass vessel, a brilliant deposit of metallic silver was formed on the surface of the glass.

Since that time, a great variety of formulæ have been issued, including the use of cold as well as hot solutions. In many cases, however, these give insufficient data regarding concentration of solutions, working temperature, etc. In particular, if the concentrations used are too high, poor results are invariably obtained.

It is proposed here to give the three standard methods, in a somewhat simplified form. All these have been thoroughly tested and should give excellent results with glass and the other non-metallic substances specified earlier in this paper, if the instructions are carefully followed.

The U.S. Bureau of Standards have issued a circular[1] on methods of silvering glass, which summarizes methods used by the Bureau for silvering mirrors, *e.g.*, for astronomical telescopes, etc. This circular contains a mass of very useful information. Unfortunately, however, it is not readily accessible in this country (England) and the formulæ given are considerably more complicated than are required for ordinary use and application.

(ii) Practical

The three formulæ to be given are:—

(1) The Cane Sugar Formula (Brashear)
(2) The Formaldehyde Formula
(3) The Rochelle Salt Formula

† Reprinted from J. Electrodepositors' Tech. Soc. **17**, 1-10 (1941).

1. Circular 389. U. S. Bureau of Standards (1931).

In each case the same general procedure is recommended.

It will be realized that the immersion silvering of a non-metallic surface is totally different in principle from the immersion silvering of a metallic surface, which is familiar to electroplaters. With a metal, displacement of silver from one of its salts by the metal being silvered takes place at the surface, and in many cases surface alloy formation occurs to a greater or lesser extent. Such surface alloy formation is of course one of the contributory factors for good adhesion of the deposit.

In the immersion silvering of a non-metallic surface, an ammoniacal solution of a silver salt is chemically reduced to metal in the solution by a suitable reducing agent, and the silver so produced deposits on the non-metallic surface. It follows from this that the adhesion of the silver deposits to the non-metallic surface will not be expected to be so strong as to a basis metal. Nevertheless, with a suitably prepared surface, the strength of adhesion of silver to such surfaces is surprisingly high.

PREPARATION OF THE NON-METALLIC SURFACE PRIOR TO DEPOSITION OF SILVER COATING

(I) Cleaning

The precautions as to cleaning and removal of grease from the non-metallic surface prior to silvering are just as important as in preparation for electroplating. The slightest trace of grease gives rise to a defective deposit.

The methods of cleaning which are available vary with the material. Obviously, electrolytic cleaners cannot be applied. With glass, porcelain and mica, solvent degreasing† is very effective.This cannot safely be used with celluloid or plastics generally on account of solvent action. Thorough cleaning and scouring with soap and warm water or weak alkali solution is suitable for these materials, followed by liberal rinsing with water. Scouring with whiting and water is also recommended. Nitric acid is frequently recommended for the preliminary cleaning of glass surfaces.

(II) Priming

In order to obtain good results, it is essential to treat the clean surface of the material, prior to silvering, with a priming (sensitizing) solution consisting of stannous chloride (tin protochloride). It cannot be too strongly emphasized that the omission of this preliminary treatment may lead to complete failure to obtain good results. It may be added that many formulæ omit to specify the use of this priming solution. The recommended concentration of the priming solution varies in different formulæ, but I have found that a 5—10% solution of the stannous chloride gives excellent results.

The method of application of the priming solution is either by simple immersion, followed by very thorough rinsing, or by gentle swabbing with a piece of cotton wool soaked in the solution. After rinsing, the article is immediately transferred to the silvering bath. It is essential to rinse away any adhering stannous chloride solution, otherwise the subsequent silver deposit is liable to be mottled in appearance. There need be no fear of removing all the stannous chloride by too thorough rinsing. *Results indicate that this is strongly adsorbed at the non-metallic surface.*

The mode of operation of the stannous chloride has been variously interpreted. There is no doubt that it has a double function, viz.: of insuring a good silver deposit, and also good adherence. It has been suggested that in the case of glass, a silicate of tin is formed at the surface (F. Fafet, Journal. Soc. Chem. Ind., 1898, 154). This suggestion obviously does not explain the equal effectiveness of the stannous chloride as a priming agent in the silvering of materials other than glass.

A further suggestion is that the stannous chloride functions as a degreasing agent, displacing grease from the surface[2].

However, it seems much more reasonable to suppose that the true function of the priming agent is to initiate the deposition of the silver on the surface by the production of nuclei of silver particles through initial reduction by the adsorbed layer of stannous chloride, and to increase adhesion through the adsorption forces operating at the surface.

Unlike immersion silvering of metals, the silver deposit tends to form equally on the containing vessel, and any means of attracting the silver to the article being silvered will increase the efficiency of the process. Several formulæ recommended warming the article to be silvered to a temperature slightly above that of the solution, immediately prior to silvering, *e.g.*, by a final rinse in warm water. This also appears to serve the same object *i.e.*, of accelerating the silvering process at the warmer surface of the article, so tending to promote deposition on the article in preference to the container.

PREPARATION OF THE AMMONIACAL SILVER SOLUTION

This follows the same general course for all three formulæ but the formaldehyde formula omits the treatment with potassium hydroxide.

To 200 c.c. of the solution of silver nitrate, add the stock ammonium hydroxide solution drop by drop, with constant stirring, until the yellowish brown precipitate of silver hydroxide just redissolves. Add 10 c.c. of the stock solution of potassium hydroxide. Precipitation will again occur, a dark brown precipitate being formed. The ammonium hydroxide solution is again added, drop by drop, with constant stirring, until the precipitate just redissolves, giving a clear solution. Any excess of ammonium hydroxide is to be avoided.

The volume of the reducing agent specified in the formula is then added, the solutions well mixed and the article to be silvered immersed. The silvering will be complete after 5—10 minutes. No advantage is gained in most cases by a longer period of immersion than 15 minutes.

It is important to keep the article being silvered in motion throughout the silvering. If a flat surface is being treated, an ordinary photographic developing dish is very convenient, and this is rocked during silvering in the usual way. Other articles may be kept in motion by other suitable means.

The process does not seem to lend itself to batch treatment, articles needing to be dealt with singly, each in a small bath. For obvious reasons, the minimum amount of solution required to cover the article is desirable.

† Emulsifiable solvent cleaning is also effective.—Ed.

2. W. W. Wall. Brit. Journ. Phot., 1919, p. 370.

(1) The Cane Sugar Formula

This is often known as the Brashear Formula (1884), and has been generally adopted for the silvering of mirrors for astronomical telescopes[3]. The formula given below is slightly modified from G. S. Newth[4], and gives excellent results using a cold solution, with glass and other non-metallic materials. The best results are obtained at 70°—80°F. The following solutions must be prepared:—

Stock Solution A (Reducing Solution).

Cane (granulated) sugar	100 g.
Nitric acid, sp. gr. 1.22	5 cc.
Alcohol	200 "

Make up to 1 liter with water. This solution improves with keeping.

Stock Solution B.

10 grams silver nitrate per liter of water.

Stock Solution C.

200 c.c. strong ammonia solution (0·880 sp. gr.) diluted to 1 liter.

Stock Solution D.

10 grams potassium hydroxide dissolved in 100 c.c. water.

For use, 10 c.c. of solution A are added to each 200 c.c. of solution B. after preparation of the ammoniacal solution as described above.

(2) The Formaldehyde Formula

The following stock solutions are required:—

Solution A (Reducing Solution)

Dilute 50 c.c. of formalin solution (40% formaldehyde to 1 liter.

Solution B (silver-nitrate) and

Solution C (ammonium hydroxide), as in the cane sugar formula.

For use, add 10 c.c. of solution A to each 100 c.c. of the silver nitrate solution, after preparation of the ammoniacal solution as described above. Note that potassium hydroxide is omitted in this case.

(3) The Rochelle Salt Formula

The following stock solutions are required:

Solution A (Reducing Solution).

100 grams of Rochelle salt are dissolved in water and made up to 1 liter.

Solution B (silver nitrate).

Solution C (ammonium hydroxide) and

Solution D (potassium hydroxide) as in the cane sugar formula.

For use, add 20 c.c. of solution A to each 100 c.c. of the silver nitrate solution, after preparation of the ammoniacal solution as described above.

Although the Rochelle salt formula is usually recommended for silvering in hot solutions, it will be found that provided the procedure already described for priming is followed, good results are obtained with cold solutions. If the stannous chloride priming is omitted in this case, no silvering occurs in this solution in the cold.

3. G. W. Ritchey. "The modern reflecting telescope," Smithsonian contributions to knowledge, XXXIV, 40.
4. G. S. Newth. "Chemical Lecture Experiments," p. 325.

FURTHER PRACTICAL OBSERVATIONS

It is interesting to note that a freshly silvered surface, on immediate immersion in a fresh portion of the silvering solution, is capable of taking a further silver deposit, and this method has been used to produce thicker deposits of silver.

The usual methods of stopping off with wax or lacquer can be used in silvering as in electrodeposition when required.

If the silver deposit is to be subsequently electroplated, it may be "quicked" by brushing over with a dilute solution of mercury cyanide, or by immersion in the solution of mercury cyanide, to provide better adhesion.

EFFICIENCY OF THE PROCESS AND RECOVERY OF SILVER

Compared with electrodeposition processes, or silvering of metallic surfaces, the deposition of silver coatings on non-metallic surfaces must be regarded as relatively uneconomic. Some confusion of ideas seems to exist in the literature. Thus it has been stated that most of the silver in the solution is deposited on the surface[5]. However, it may be stated that in most cases much more silver is precipitated during the process than is deposited on the surface. This may be illustrated by data taken from one experiment described later in this paper, in which a silver deposit weighing 0.0040 gram was made on glass from a solution originally containing 0.32 gram silver as silver nitrate. This experiment indicates that one-eightieth of the original silver was deposited on the article. The remaining silver was either deposited on the wall of the containing vessel (a relatively small amount) or deposited as a dark brown precipitate.

The obvious course would appear to be either to use a much more dilute solution or to recover the silver from the residues. The disadvantage of using dilute solutions is the slowness of the silvering process. Thus, experiments by Silverman and Howe[6] show that, using a solution containing 6 g./l. of silver nitrate, under suitable conditions, 20% of the silver is deposited in 40 minutes on the working surface.

If silver is to be recovered from the solution, this must be as silver chloride. The residue in the silvering bath is dissolved in nitric acid, and silver chloride precipitated by the addition of sodium chloride solution. The black precipitate remaining after silvering is explosive when dry, and therefore no attempt should be made to recover the silver in this form.

THICKNESS OF SILVER DEPOSITS ON NON-METALLIC SURFACES

Earlier observations on the silver deposits on glass show that there is a limit to the thickness of the deposits, and that such deposits are considerably thinner than are common in the electrodeposition of silver, although they are frequently opaque, and will stand polishing with rouge. It is in fact possible by very short periods of immersion, to obtain silver deposits on glass or celluloid so thin that they transmit light, giving a blue colour when viewed in direct light.

5. J. Graham. Brit. Journ. Phot., 1919, p. 155.
6. A. Silverman and R. M. Howe. J. Ind. Eng. Chem., 9, p. 1,032 (1918).

Circular 389 of the U. S. Bureau of Standards describes an optical method for obtaining an approximate value for the thickness of silver deposits on glass, using a method described by Fizeau [Ann. Chem. Phys., *63*, p. 385 (1861)]. This will be referred to later; no direct measurements of thickness, however, appear to have been made, so far as I have been able to ascertain.

It was therefore regarded as a matter of interest to attempt to determine the thickness of such silver deposits by a direct method. The method devised made it possible to follow the rate at which silver was being deposited from the bath.

In these experiments, Formula 1 (Cane Sugar Formula) was used for the actual silvering. A number of thin glass microscope slides (2.5×7.5 cm.) each weighing approximately 4 grams, were thoroughly cleaned, then degreased in trichlorethylene, dried, and weighed. Each slide was then separately silvered for a different time in a bath containing 50 cc. of 1% silver nitrate solution (ammoniacal) and 2.5 cc. of reducing sugar solution, after priming with stannous chloride solution. After silvering they were thoroughly rinsed, first with distilled water then with acetone, dried without handling and again weighed.

Although the weight of the silver deposit was very small, it was measurable to an accuracy of 0.0001 gram with the balance used. The area of the silvered surface was calculated in each case, since the whole of the slide was not immersed during silvering. Taking the density of silver as 10.5 g./cc., the thickness of the deposit may be calculated using the formula:

$$T = \frac{W}{10.5 \times A}$$

Where T = Thickness of deposit (cm.).
W = Weight of deposit (g.).
A = Area of deposit (sq. cm.).

The results are given in Table I.

TABLE I.

Experiment No.	Time of Silvering (Minutes)	Weight of Silver Deposit (Grams)	Area of Silver Deposit (CM^2)	Thickness of Silver Deposit. Cm.	In.
1	0.5	0.0006	24.5	0.0000023	0.000001
2	1.0	0.0004	23.0	0.0000017	0.0000007
3	1.5	0.0006	23.0	0.0000025	0.000001
4	2.0	0.0018	22.5	0.0000076	0.000003
5	2.5	0.0016	21.8	0.0000070	0.000003
6	5	0.0023	22.9	0.0000096	0.0000038
7	10	0.0031	20.8	0.0000142	0.0000056
8	20	0.0026	16.2	0.0000154	0.0000061

Table I indicates that during the first half-minute, a silver deposit one-millionth of an inch thick forms, probably with great rapidity, judging by visual observation. This deposit shows no marked increase in thickness until two minutes have elapsed, when the thickness increases fairly rapidly to three millionths of an inch. The rate of increase then slows down, and after ten minutes very little further increase of thickness occurs. The final thickness is approximately six millionths of an inch.

Deposits from experiments 1, 2 and 3 transmitted blue light and gave poor mirrors. The other deposits were opaque to ordinary white light, and formed good mirrors.

It would not be wise to draw general conclusions from this single series of experiments with a single silvering solution, but it seems reasonable to suppose that the figures give an indication of the average thickness of the silver coating normally deposited in this way.

Further experiments are in progress on the measurement of the thickness of the deposits obtained with other solutions, and by varying the experimental conditions; no doubt by the use of a semi-micro balance the accuracy of the results could be further increased.

It is interesting to compare these figures with those for the thickness of silver foil. The thinnest silver foil obtainable is stated to have a thickness of 0.000025 cm. (Roscoe and Schorlemmer "Treatise on Chemistry" Vol. I, p. 458), or 0.00001 inch. This compares with 0.000006 inch for the thickest silver deposit obtained above. It thus appears that the thinnest silver foil available is comparable in thickness with the thickest silver deposit obtainable by chemical deposition, although silver deposits of one-tenth this thickness are obtainable by silvering processes.

It may also be of interest to compare these results with the minimum thickness of silver usual for electroplated goods, viz., 0.0006 inch, from which it appears that the silver deposits are one-hundredth the thickness of commercial silver electrodeposits.

The silver deposits obtained in the experiments of Table I were also used to calibrate the method for the approximate measurement of thickness described in Circular 389 of the U. S. Bureau of Standards. Each of the deposits obtained in experiments 1—8 of Table I were examined following this method.

A very small crystal of iodine is placed on a porcelain tile, or other flat surface, and the slide carrying the silver deposit is supported so that the surface is 1-2 mm. above the crystal. After 5-10 minutes, varying with the conditions, the silver deposit immediately above the iodine crystal is converted into transparent silver iodide, producing a central transparent spot. The neighboring portion of the deposit is partially converted into silver iodide, and when the deposit is viewed by reflected light, the transparent central spot of silver is surrounded by a series of concentric colored rings. The number of rings present, including the transparent central spot, is a measure of the thickness of the silver iodide at the center of the pattern, and this in turn is a measure of the thickness of the silver deposit. The actual values for the thickness are derived by computations based on the refractive index of silver iodide. To determine the thickness of the deposit, reference is made to a table.

TABLE II.

No. of Rings	2	3	4	5	6	7
Thickness (x 10^{-6} mm.)	31	61	92	123	154	215

According to the U. S. Bureau of Standards, from data obtained using this method, the thickness of silver deposits on glass may vary from 30×10^{-6} mm. for a very thin deposit to approximately 200×10^{-6} mm. for a very thick deposit.

The results of the calibration of the method using the eight deposits of Table I are given for comparison in Table III.

(*Concluded on page* 610)

American Hot-Dip Tinning Practice

5.

TREATMENT OF THE BY-PRODUCTS OF THE HOT-DIP TINNING PROCESS

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There is very little published information on methods of treating the by-products from hot-dip tinning. In this article, the author summarizes methods known to himself and discusses the few methods mentioned in the literature. Boiling of the bath with wood is first considered and then the various types of by-products are described. Three methods are given for the treatment of oxide skimmings, and drawings are given to illustrate the general construction of tin residue treating furnaces.—Ed.

THERE seems to be very little practical knowledge available upon any good method of treating the by-products from hot-dip tinning. This is not at all surprising since there is really a very limited amount of knowledge available upon the hot-dip tinning process itself. Therefore, the following methods herein described are probably the best methods available, and a very large part of the information is the writer's own experience as a practical hot-dip tinning superintendent and that gained from being a consultant in going around visiting various hot-dip tinning plants over the country.

Boiling Out the Tin Bath

In making the final clean-up of the operating tin pots to obtain all of the by-products just before treatment, the tin baths in operation should be thoroughly purified by a boiling out process. The boiling consists of introducing into the molten tin bath a log of green timber. The wood at the high temperature undergoes a dry distillation and the gas and vapor given off set up a bubbling action in the bath of metal. By this means, every portion of the bath is brought into contact with the air, the foreign materials, and a portion of the tin being oxidized. Oxides, scruf, and dirt in the tin are also carried upward by the boiling action, and remain as oxide skimmings on the bath surface.

Boiling out, or poling, in some plants is done with a piece of hardwood block about 4 x 12 inches that has been soaked in water. It is then speared with a sharp light steel rod, and the block on the steel rod slowly pushed down into the molten tin, and held there until the bath has been thoroughly boiled out. Still other plants use a raw potato on a spear, and still others raw beets. The idea of course is to put something into the bath that will make it boil violently but will not spatter the tin out of the pot. The boiling action is to bring all of the oxides, scruf, and foreign matter held in the tin bath, up to the surface. Often a nice two-by-four of soft yellow pine is used. This contains rosin, and the gas formed in the charring of the wood and the burning of the rosin causes violent boiling in the metal. The rosin also tends to give a reducing action on the tin and thereby return some of the tin from the oxides back into the tin bath.

What are the By-Products

In the cleaning of the tin bath, sal ammoniac and powdered rosin are used as the fluxes. The oxides collect in a foamy mass and the so-called "boil scum" on the surface of the bath is skimmed off. The duration of the boiling depends upon the state of purity. When the surface of the metal is clean, bright, and shining it indicates that refining is complete.

The by-products of hot-dip tinning consist of a number of materials depending largely on what kind of hot-dip tinning is being done and the type of fluxes and greases used. In just the usual hot-dip tinning process where the flux is liquid zinc ammonium chloride, and perhaps a little white powdered sal ammoniac, the by-products consist mainly of oxide skimmings, mixtures of liquid, or black slag tin flux and oxide skimmings, tin shot, and tin dross. The black powder is largely tin oxide and flux; the tin dross is largely metallic tin and iron. The chemical formula assigned to this iron-tin alloy is one part of iron to two parts of tin, $FeSn_2$.

Just how much of the tin can be reclaimed from the tin dross will depend largely upon how carefully the dross has been taken. In some cases a large amount of free tin or good metal is removed from the dross. In some cases it

is possible to reclaim almost 70% of the tin.

One very good method of refining the tin dross consists of liquation of the tin in a sweating furnace, and subsequently purifying by boiling as described above. The furnace used for liquation is one in which the heat can be controlled. The sweating process, which consists in placing the tin dross on the bottom of the furnace lining, where it is subjected to a very slow, soft reducing flame, is carried on at a temperature just slightly above the melting point of the tin which is 450°F. The sweating should be done at as low a temperature as possible, 460 to 475°F.

By this means, the tin is very gradually liquified, melting away in a manner something like the melting of cakes of ice, and run off down the sloping bottom of the furnace where it is caught in a mold or tapping kettle. It is impossible to reclaim all of the tin by this method, since a part of it is actually chemically combined with the iron. This residue will remain on the furnace bottom and can be sold to a smelter, as that is the only way the iron can be separated from this remaining tin.

Treatment of the Oxide Skimmings

FIRST METHOD

The oxide skimmings from the surface of the tin bath always contain a large amount of tin shot and good tin which splashes out when the skimmings are removed. There are a number of ways of treating this material. Since it contains a large amount of free tin shot, the first treatment is usually to place a suitable amount of the skimmings on top of the tin bath of a reclaiming kettle. Considerable care *must be exercised* that the bath is *not-overheated* in this process. A perforated saucer-shaped scoop is used to work the skimmings back and forth over the bath. Sal ammoniac and rosin are mixed with the skimmings to furnish heat to remelt the tin so that it can run back into the bath. Just as soon as the sal ammoniac and rosin are mixed in with the skimmings, throw a match into the gas formed to ignite it. It will burn with much heat causing the small tin balls to again unite with the bath. The skimmings are worked back and forth on the bath until all of the metal has disappeared and there is nothing but the residue left which contains no metal. Then this is skimmed off the tin bath and a new batch of oxide skimmings put on and treated in the same way to get the metallic tin out. The process is continued until all the skimmings have been treated. The residue will probably contain a very small amount of tin.

SECOND METHOD

In this method, the skimmings are treated on a furnace with a sloping hot plate. The soft low fire is underneath, and the skimmings are spread out over the plate until thoroughly heated. Small metallic tin balls will melt and run down the plate and collect in a well at the front. The residue up on the plate is then covered with a shower of sal ammoniac and powdered rosin, and then stirred vigorously. The smoke given off is ignited and burns giving additional heat to melt the tin.

Fresh additions of skimmings are put on the plate from time to time and worked well with sal ammoniac and rosin. Finally enough tin collects at the bottom and front of the pan to run it off into a pig. The pipe can be stopped up with a little fireclay and then the burning off again resumed. Finally all of the skimmings have been treated to reclaim the metallics. All of the tin is then put into the reclaiming melting tin pot, and again treated with sal ammoniac and rosin and boiled to refine it. It is finally poured or dipped out into pigs.

THIRD METHOD

This method is the same as used in reclaiming zinc metallics from the zinc skimmings from hot-dip galvanizing pots, and the writer sees no reason why the same technique cannot also be used to good advantage in reclaiming tin metallics from tin pot skimmings. The skimmings are first placed in a large old steel pot, then the pot is filled with water and a live steam line is run into it similar to a pickle tank. The boiling water dissolves the soluble materials, and the insoluble material and metallic tin settle, or stay in the bottom of the pot. The top liquor is then run off after all the pieces have been broken and as much of them dissolved as possible by a thorough stirring.

The material remaining as a residue on the bottom of the pot is then placed on a hot-plate furnace as above described, and the material slowly dried. The plate is the sloping plate mentioned above. The skimmings are then mixed with sal ammoniac and rosin and stirred thoroughly, the metallic tin running down and settling at the front of the plate while the dust and skimmings and powder are pushed back up to the top. The tin is then tapped off into pigs.

Smelting Tin Dross

Under this title, there is a short article by W. J. Reardon in the Metal Industry (N. Y.) of September, 1937. It is as follows:

"Q. We have a problem in running tin dross containing some iron. The iron slags off and takes with it a considerable amount of the metallic tin, and we wish to find a flux with which we could flux the iron off as slag removing any tin without iron.

A. We suggest that you try a flux composed of—

Iron scale	100 lb.
Lime	50 "
Coal dust	200 "
Silica sand	75 "
Soda ash	15 "
Fluorspar	50 "

Mix this material well and add 20% of the flux. The iron will throw down the tin and lead and flux off the slag nicely. If the slag shows any tin, increase the iron content. This will help eliminate tin and lead from your slag.

W. J. Reardon."

Treating of Oxide Skimmings

In searching around for all the information I could find, or could adapt to our use, I came across an item in the book of "Analytical Chemistry" by Treadwell and Hall. On page 260 the following item has been found—

FUSION OF OXIDE SKIMMINGS WITH SODIUM CARBONATE AND SULPHUR

Place the dry skimmings in a container; mix with six times as much calcined sodium carbonate and sulphur (equal parts mixed), cover, and heat with a small flame until the excess of sulphur has distilled off and burned. This operation requires about twenty minutes. Allow to cool

and then treat the contents with hot water, and filter if necessary.

$$2SnO_2 + 2Na_2CO_3 + 9S = 3SO_2\uparrow + 2Na_2SnS_3 + 2CO_2\uparrow$$

If iron, lead, copper, or any other metal that forms a sulphide insoluble in water and ammonium polysulphide is present, it remains undissolved as sulphide, and is separated from the tin by filtration.

Different Kinds of Tin Residues

Since there is almost no information at all available on the treating of tin residues, and in fact the general term of "tin drosses" has been used to cover every kind of a by-product, it is well at this time to give some basis for dividing these various materials intelligently for treatment.

Tin dross is the tin-iron alloy that accumulates in the bottom of the tin pot. Sometimes due to the fact that the tin pot is heated on the bottom, thus having heat currents carry the tin-iron alloy upwards, tin dross becomes mixed in with the skimmings.

Oxide skimmings are the powdered material and sometimes the black refuse mixture of flux, oxide, and tin dross skimmed off the top of the tin bath. Oxide skimmings can be generally divided into two kinds of skimmings, or wastes, namely, the flux-mixed, or sal ammoniac (black) oxide skimmings, and in grease hot-dip tinning, the black grease tin wastes. Therefore there are at least three tin waste products to be considered, namely, tin dross, sal ammoniac skimmings, or flux skimmings, and grease skimmings. In some cases all of these are mixed; in others the tin dross is separate, and in still others, tin dross and sal ammoniac skimmings are mixed.

To prepare them for treatment, as much separation of distinct by-products should be done as possible. Good metal and tin dross (tin-iron alloy) should be one class; the black mixture of tin dross and flux and oxide skimmings another, and if grease is used, this should be the third separation.

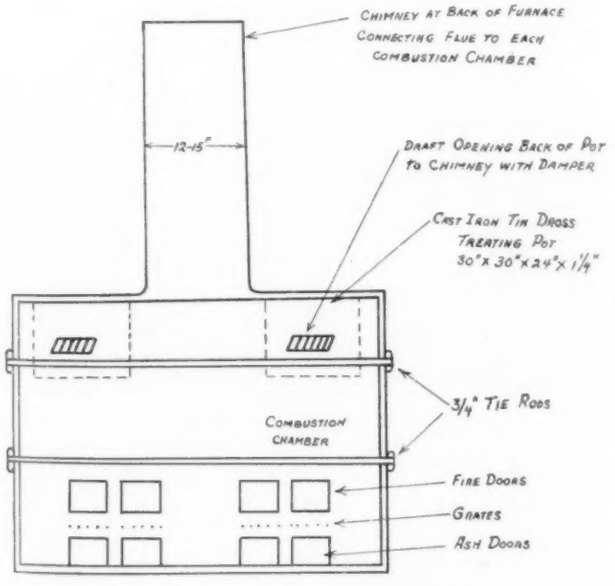
Each one of these residues must be prepared for treatment. The actual metal residues are ready to be treated at once. Since the black flux residue contains metal, tin oxide powder, and sal ammoniac or zinc chloride liquid flux, this residue should first be treated with hot water to dissolve out all of the flux (chlorides which are soluble in hot water). The oxide of tin and the metallic tin shot etc. will remain. Separate the chloride liquor by draining off; the solid material remaining will be largely tin oxide and tin metallics. This should be dried, and then the oxide skimmings separated from the metal by screening or tumbling. The tin metallics should be placed with the other tin metal, and tin dross, and the oxide skimmings placed with the oxide residues. In the case of a third residue from grease tinning, the grease should be gently burned off first, and after all of the grease is gone, the remainder will be oxide and metallics which should be separated in the same method as the black flux materials were separated.

Rough sketches of the two types of reclaiming furnaces used are given. The first is the usual type of tin pot setting, and the only difference is that the pot is a melting pot used to treat and work up the alloy and metal. The high quality tin is decanted off, and the tin-iron alloy remains. The residues are worked in this pot to melt up all of the metallics. The skimmings are then taken off the top for further treatment and the good tin metal is decanted off. The second furnace is used for treating the tin oxide skimmings and consists of a sloping plate where the tin metal can be run down and drained off.

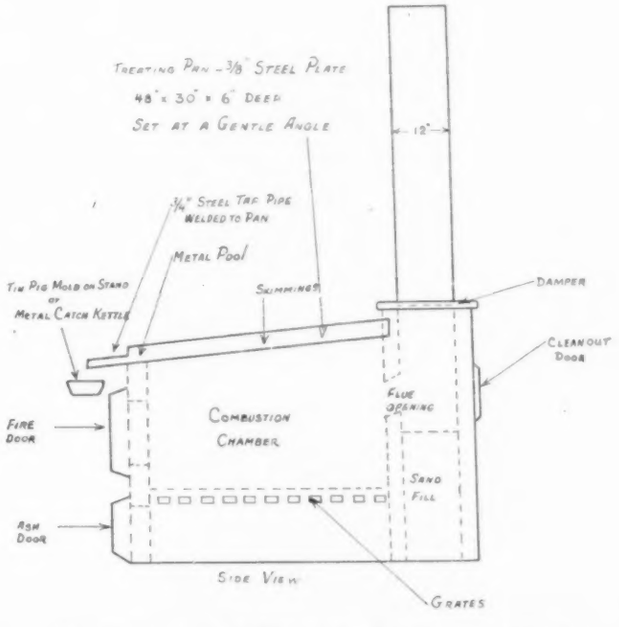
Drawing Number 1

The drawings submitted do not show the details because they are simple ordinary furnaces to build. The only confusing thing perhaps in this drawing is that it is hard to show the outlet flue from each combustion chamber, back into another main flue leading to the stack.

This double furnace is really two distinct furnaces. The


Chimney at Back of Furnace
Connecting Flue to Each Combustion Chamber
12-15"
Draft Opening Back of Pot to Chimney with Damper
Cast Iron Tin Dross Treating Pot 30"x 30"x 24"x 1¼"
3/4" Tie Rods
Combustion Chamber
Fire Doors
Grates
Ash Doors

Drawing No. 1. Front view of tin by-product furnace. The combustion and heating of each pot is done independently. The connections to stack are at the back of the furnace.



Drawing No. 2. Side view of skimmings treating furnace.

dividing wall between the pots separates the two completely. Each pot temperature is controlled by a damper in the flue at the back of the furnace before it gets to the stack. This makes the combustion in each combustion chamber entirely independent of the other. It is not necessary to put a damper on the main stack although it can be done for accurate control.

The size of the furnace over all can be made to suit the pots the dimensions of which are given. The furnace is held together by the usual corner angles and tie-rod construction. The fire doors, ash doors, and grates are the standard design.

The pot on the right is used for sweating the tin dross very slowly, and the pot on the left contains the tin bath called "rough tin" where the oxide skimmings are placed on the surface and worked with sal ammoniac and rosin as already described. The good tin from the tin dross and also tin collected from the reclaiming skimmings pan shown in Drawing No. 2 are placed in the left hand pot of this furnace and refined with sal ammoniac and rosin.

The main thing to watch is overheating. Tin melts at 450°F.; work between 460 to 475°F. Work always at as low a temperature as possible. Use a pyrometer to measure the temperatures.

Drawing Number 2

This drawing shows the general construction of the tin skimmings reclaiming furnace. There is nothing difficult in building this furnace. The size of the furnace itself can be made to suit the size of the pan.

The tin oxide skimmings with fine tin shot in it are spread out over this reclaiming plate near the middle of the plate. Sal ammoniac and rosin are mixed in with the skimmings as they are stirred, and the gas generated is ignited. The heat under the plate causes the tin shot to melt and run down the plate in a pool at the front of the pan. When the puddle is large enough, the clay is poked out of the pipe and the metal tapped off either into a small kettle or into a tin pig mold.

The back of the stack is filled with sand to eliminate gas pockets which may be the cause of an explosion. Make the stack either solid to this point or else fill it with sand to eliminate this gas pocket.

In the back of the stack is a small clean-out door. This can be made any suitable size. The stack is provided with a damper to control the fire whenever needed. Both of these reclaiming furnaces should be placed under one roof where no water or rain can get on them. It is not possible of course to reclaim all of the tin, but a very large part of it can be reclaimed and the residue left can then be sold to the smelter. *Again attention is called to the fact that the success of this reclaiming operation depends upon careful control of the temperature.*

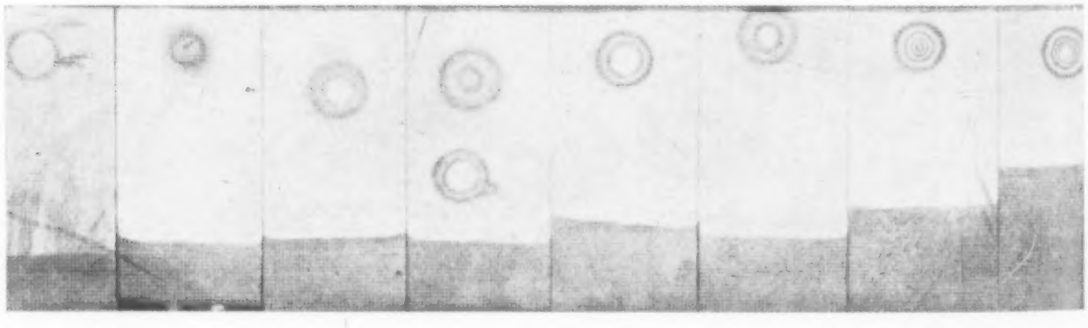
Silver Coatings on Non-Metallic Surfaces

(*Concluded from page 606*)

TABLE III.

No. of Deposit	1	2	3	4	5	6	7	8
No. of Rings	2	2	3	4	4	4	5	5
Thickness (Optical Method) Cm. x 10^{-6}	3.1	3.1	6.1	9.2	9.2	9.2	12.3	12.3
Thickness (Weight Method) Cm. x 10^{-6}	2.3	1.7	2.5	7.6	7.0	9.6	14.2	15.4

It will be seen that, considering the small magnitudes involved, the agreement is quite good. It thus appears that, although not capable of giving results of a very high degree of accuracy, the optical method of Fizeau is a rapid and simple method of obtaining an approximate thickness figure for silver deposits on non-metallic surfaces. It also offers the possibility of detecting sharp variations in the thickness of silver deposits on a large surface. An obvious disadvantage is that it is a destructive test.



Calibration of optical method for thickness of silver deposit.

No. of Deposit	1	2	3	4	5	6	7	8
No. of Rings	2	2	3	4	4	4	5	5
Thickness (Optical Method) Cm. x 10^{-6}	3·1	3·1	6·1	9·2	9·2	9.2	12·3	12·3
Thickness (Weight Method) Cm. x 10^{-6}	2·3	1·7	2·5	7·6	7·0	9·6	14·2	15·4

(*Note:—In deposits Nos.* 4, 5 *and* 6 *the ring systems are very closely spaced and one ring in each case is not clearly shown in the photograph*).

Addition Agents in Nickel Plating

BY LESLIE L. LINICK

Linick, Green & Reed, Inc.,
Chicago, Ill.

THE writer herewith presents a report on the effects of phenyl related compounds in the Watts type nickel solution. The average temperature of the solution used was 125° F. ± 5° and current densities in most cases were 25 amp./ft.² at the start of plating and increased to about 75 amp./ft.² In certain cases, the current density was even higher. The results mentioned, referred in each case to the best plate obtainable and the experiments were made over a period of several years. The compounds chosen are all organic or metallo-organic and are those that were considered most logical brighteners because of their composition. The results are based upon a concentration in most cases of 1 cc. per gallon of the addition agent.

ACETOBENZYLAMIDE—$C_6H_5CH_2NHCOCH_3$
Almost insoluble—precipitates after electrolysis.

PHENYLACETANILIDE—$(C_6H_5)_2NCOCH_3$
Only about ½ cc. dissolves per gallon—temporary brightener—eventually leaves nitrogen compound separate, which interferes with deposition.

BENZOYLACETIC ACID—$C_6H_5COCH_2COOH$
Slightly soluble—yellowish bright deposit.

DIPHENYLACETIC ACID—$(C_6H_5)_2CHCOOH$
Dissolves freely—brown bright deposit.

GLYCOLIC ACID PHENYL ETHER—$C_6H_5OCH_2COOH$
Dissolves freely—short, temporary brightening effect.

BENZYLACETONE—$C_6H_5CH \cdot CHCOCH_3$
Almost insoluble, dark striations and temporary lineal formations.

BENZOYLACETONE—$C_6H_5COCH_2COCH_3$
Slightly soluble but decomposed by acid—no noticeable effect.

BENZOYLACETONITRILE—$C_6H_5COCH_2CN$
Soluble to about 1½ cc. per gallon—seriously interferes with deposition.

ACETOPHENONEOXIME—$C_6H_5C(N \cdot OH)CH_3$
Slightly soluble—bright, non-adhering deposit.

BENZOYL CARBINOL—$C_6H_5COCH_2OH$
Freely soluble—excellent but very temporary brightener.

PHENYLACETURIC ACID—$C_6H_5N(CH_3CO)CH_2COOH$
Almost insoluble—precipitates after electrolysis.

DIPHENYLACETYLENE—$C_6H_5CC \cdot C_6H_5$
Insoluble—no effect.

PHENYLACRIDINE—$C_6H_5C_{13}H_8N$
Almost insoluble—nitrate formation eventually stops deposition.

PHENYLALANINE—$C_6H_5CH_2CH(NH_2)COOH$
Soluble to about 5 cc. per gallon—excellent mirror bright deposit—extremely brittle.

TANTALUM AMARINE SULPHIDE—
$(C_6H_5)CH(Ta_2S_4)C_6H_5(CH)$
Soluble to about 8 cc. per gallon—requires breaking in by electrolysis—bright, well-adhering deposit which is brittle only in presence of ammonium compounds.

ANILINE—$C_6H_5NH_2$
Soluble to about 6 cc. per gallon—slowly combines to form nickelaminobenzene, extremely bright and very brittle deposit.

ANILINE HYDROCHLORIDE—$C_6H_5NH_2 \cdot HCl$
Soluble to about 12 cc. per gallon—identical in effect to aniline.

CALCIUM BENZOATE—$(C_6H_5CO_2)_2Ca \cdot 3H_2O$
Soluble to about 4 cc. per gallon—mild brightening effect, poor adherence of deposit.

MAGNESIUM CITRATE—$(C_6H_5O_7)_2Mg_3 \cdot 14H_2O$
Dissolves to about ½ cc. per gallon—bright but coarse, well adhering deposit, eventually showing striations and dark fine lines.

TIN DIPHENYLDIBROMIDE—$(C_6H_5)_2Sn\,Br_2$
Slightly soluble, dark, glossy, poorly adhering deposit.

COBALT BENZOATE—$(C_6H_5CO_2)_2Co \cdot 4H_2O$
Freely soluble—very temporary bright, hard deposit of white color.

DIBENZYLMERCURY—$(C_7H_7)_2Hg$

DIPHENYLMERCURY—$(C_6H_5 \cdot C_6H_4)_2Hg$
These are not soluble alone but slightly soluble in equal amounts. Bright but slightly blistered deposit. After continued deposition, the effect is rather pleasing in areas.

POTASSIUM PHENOLSULPHONATE—$C_6H_5O_4SK \cdot 2H_2O$
Slightly soluble—temporary brightener, ductile deposit.

SILICON DINITROSODIPHENYLAMINEFLUOSILICATE—
$[(C_6H_5)_2N \cdot NO]_2H_2SiF_6$
Very slightly soluble—gray, bright, very hard deposit. (Suitable for demonstrating effect of minute additions of metallo-organic compounds.)

SODIUM BENZENESULPHONATE—$C_6H_5NaSO_3$
Very soluble—bright, extremely brittle, poor-adhering deposit, suitable for demonstrating effect of sodium—in contrast with:

BENZENESULPHONIC ACID—$C_6H_5SO_3H$
Very soluble—bright, ductile, well-adhering deposit of poor color, irregular shading.

PHENYL SULPHOCYANATE—C_6H_5SCN
Almost insoluble—combines with acid to form insoluble precipitate.

TRIBENZYL TIN CHLORIDE—$(C_6H_5CH_2)_3SnCl$
Slowly soluble (in presence of chlorine) glossy, dark, poorly adhering deposit.

(*Concluded on page* 614)

The Analysis of Silver Plating Solutions[1]

By HAROLD J. READ[2] AND CATHERINE P. READ

Introduction

THE usual method employed in determining the silver content of a silver plating solution utilizes the Volhard titration with a thiocyanate solution, after destruction of the cyanide with a mixture of nitric and sulphuric acids. There are several features of this analysis which make it undesirable. The destruction of the cyanide with acid is always a dangerous process even when a good hood is available. The ammonium thiocyanate solution used in the Volhard titration cannot be made up by weighing out the reagent and diluting to a given volume, but must be standardized before use. It has been described by some writers as a relatively unstable solution, and it is not useful for any other analysis ordinarily carried out in the plating laboratory.

The analysis which the authors describe herein eliminates these undesirable features. The titration for the determination of silver is performed on a sample of the solution which is always kept in the alkaline state and is, therefore, perfectly safe. The titrating reagent is standard silver nitrate solution, and may conveniently be the same 0.1*N* solution which is used for the free cyanide titration.

Theory

The ordinary silver plating solution contains free NaCN, $NaAg(CN)_2$ and Na_2CO_3 plus possible small amounts of addition agents. Let us consider what happens when $AgNO_3$ is added to such a solution. The first reaction is:

$$2\ NaCN + AgNO_3 \rightarrow NaAg(CN)_2 + NaNO_3 \quad 1.$$

When all of the NaCN is used up, the next addition of $AgNO_3$ decomposes the complex cyanide:

$$NaAg(CN)_2 + AgNO_3 \rightarrow 2\ \underline{AgCN} + NaNO_3 \quad 2.$$

It is obvious that the total amount of $NaAg(CN)_2$ in the solution will be that produced by reaction *1.* plus the original silver complex present in the plating solution. The AgCN is insoluble and precipitates out to produce the turbidity which marks the end-point in the free cyanide titration (emphasized by the presence of AgI from the KI usually added).

If the addition of $AgNO_3$ is continued after all of the silver in the sample has been precipitated as AgCN, the next reaction will be:

$$Na_2CO_3 + 2\ AgNO_3 \rightarrow \underline{Ag_2CO_3} + 2\ NaNO_3 \quad 3.$$

and insoluble Ag_2CO_3 will be precipitated.

It is quite evident that if a means could be found to determine the end-point of reaction *2.* a method of determining the silver content of the sample by a silver nitrate titration would be available. That is, for a given sized sample, twice the volume of silver nitrate used in determining the free cyanide could be subtracted from the volume of silver nitrate used in causing both reactions *1.* and *2.* to occur—the difference would be chemically equivalent to the silver content of the sample.

If no carbonate were present to cause reaction *3.* it would appear likely that the end-point could be determined by a potentiometric method. The solution will contain practically no free silver ions up to the end of reaction *2.* The first drop of silver nitrate added beyond this point should provide a relative abundance of silver ions and radically change the potential of the solution with respect to suitable reference electrodes. This expectation was verified experimentally. However, as was to be expected, the presence of carbonate interfered with the detection of the end-point. The authors have been able to resolve this difficulty by adding enough barium nitrate to precipitate the carbonate as $BaCO_3$. Since $BaCO_3$ is more insoluble than Ag_2CO_3 it may be left in the solution while the titration is carried out, that is, a metathesis reaction will not occur with the formation of Ag_2CO_3. Directions for the performance of the potentiometric titration will be given later in this article.

While the experimental work was being done on the potentiometric method, Ripan-Tilici[3] published a paper on the argentometric titration of cyanide ions with diphenylcarbazone. In the titration of cyanide ions at a pH between 9 and 10 with silver nitrate, this indicator changes from violet to blue when all of the cyanide has been precipitated. It should, therefore, be an indicator for the end-point of reaction *2.* above—providing the carbonate in the plating solution would not interfere and the pH could be suitably controlled. The normal pH of a silver solution is about 10.3 to 10.5, and a diluted sample rises to about 10.8. A few experiments quickly indicated that the sample would have to be treated to adjust the pH before titration. Further work showed that the presence of carbonate was not a difficulty providing the pH could be brought down to about 9.3.

It is not necessary to discuss here the various schemes which were tried in an effort to easily and quickly adjust the pH to the desired value. The one to be described was the simplest and appears to be entirely satisfactory. After the sample has been measured out and somewhat diluted, sodium bicarbonate and phenolphthalein are added. A red color develops and is changed to a faint pink by rough additions of barium nitrate. This is all that is necessary to prepare the sample for titration—a simple operation compared to the destruction of the cyanide for the usual titration.

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1. This paper is a contribution from the Department of Chemistry and Chemical Engineering, University of Pennsylvania, Philadelphia, Penna.

2. Present address: Mellon Institute of Industrial Research, Pittsburgh, Penna.

3. Z. für Anal. Chem. **118,** 305 (1940).

Since the indicator method is somewhat simpler than the potentiometric method, it will be presented in detail before the latter.

Detailed Instructions for Indicator Method

The solutions which will be needed are:

1. Silver nitrate—0.1000*N* (The same solution as is used in the free cyanide titration.)
2. Diphenylcarbazone—0.3% solution in alcohol. (This indicator is made by the Eastman Kodak Co., and may be purchased direct or from the larger chemical supply houses.)
3. Phenolphthalein—0.3% solution in alcohol.
4. Sodium bicarbonate—10% solution.
5. Barium nitrate—5% solution.

Measure out exactly 5.00 cc. of silver plating solution into a 250 cc. Erlenmeyer flask and dilute with 20 cc. of water. With a small graduate, add 3 cc. of sodium bicarbonate solution followed by two drops of phenolphthalein solution. A red color will appear. Fill a 25 cc. graduate with barium nitrate solution and pour it into the sample in small increments until the red color has faded to a light but perfectly definite pink. A precipitate will form but should be disregarded. Note the amount of barium nitrate used as a guide on how much to add to subsequent samples. Usually about 20 cc. are required, but the amount may vary rather widely. Now add 6 drops of diphenylcarbazone and start to titrate with silver nitrate solution. The reddish color of the solution will fade, then as more silver nitrate is added the solution will become violet. The sample should be kept well agitated by swirling the flask. The end-point is indicated by a transition from violet to a rather dirty blue color. The precipitate will probably coagulate markedly at this point. The blue color fades to yellow in a minute or less. If necessary, a few drops more of indicator may be added near the end-point. Little or no practice will be necessary in locating the end-point as the change in color is quite definite and sharp. It is assumed that a free cyanide titration has been carefully made on another sample of the solution being analyzed. The silver content of the solution may now be found as follows: subtract twice the volume of silver nitrate used in determining the free cyanide in a 5.00 cc. sample from the volume of silver nitrate used in the diphenylcarbazone titration; the difference multiplied by 0.263 will give the silver in troy ounces per gallon.

Discussion of the Indicator Method

Three solutions were used in testing the indicator method. Table I gives the compositions of these solutions as determined by the usual methods, while Table II shows the results obtained by the diphenylcarbazone titration. The agreement exceeds the accuracy required of routine analytical methods in the plating laboratory.

Attempts to analyze silver "strike" solutions by the diphenylcarbazone method as described above were not successful. The authors have not had an opportunity to study this problem extensively and are loath to say that further work would not reveal a modification of the method which could be applied to such solutions.

It has been noted that the indicator solution has a tendency to deteriorate very slowly, hence a large quantity of the solution should not be prepared unless it will all be used within a couple of months.

Table I

Composition of Test Solutions

Solution No.	Silver Troy oz./gal.	Free Sodium Cyanide Av. oz./gal.	Sodium Carbonate Av. oz./gal.	pH
1.	3.00	1.77	6.0	10.3
2.	2.98	1.91	6.0	12.0
3.	2.76	3.24	8.0	10.3

Table II

Data are for a 5.00 cc. sample

Solution No.	Volume of 0.1*N* Silver Nitrate		Silver Troy oz./gal.
	For Free Cyanide Titration	For Diphenylcarbazone Titration	
1.	6.73	24.86	
	6.77 Av.=6.75	24.92 Av.=24.89	3.02
2.	7.29	25.74	
	7.30 Av.=7.30	25.79 Av.=25.77	2.94
3.	12.30	35.02	
	12.35 Av.=12.33	35.05 Av.=35.04	2.73

No tests were made on solutions containing potassium cyanide and potassium carbonate, but presumably the method will work equally well for such solutions. As a matter of fact, Ripan-Tilici's original paper described work which was done on potassium cyanide solutions.

Detailed Instructions for the Potentiometric Method

The necessary equipment will include the following:

1. *Electrodes*—the electrodes are simply two small pieces of wire, one platinum and the other tungsten. They should be sealed into glass tubes with about three-quarters of an inch of wire projecting beyond the glass (use soft glass for the platinum and Pyrex for the tungsten). The size of the wire is not important—No. 20 is satisfactory, but it may be larger or smaller. The glass tubes are mounted in a two-hole rubber stopper and held by an ordinary clamp. Contact with the lead wires to the meter is made with mercury in the ordinary way.

2. *Motor driven stirrer*—this must be small, compact and variable in speed.

3. *Potential measuring device*—a direct reading vacuum tube voltmeter should be used. A manually operated potentiometer could be employed, but then the titration becomes very laborious compared with the indicator method. A voltmeter of the D'Arsonval type *cannot* be used since even the finest high resistance meter will draw enough current to polarize the electrodes. The meter used by the authors was similar to that described by Garman and Droz[4]. The meter reads in microamperes which are directly proportional to the applied voltage. Many other suitable instruments have been described in the literature, the simplest probably being that of Willard and Hager[5]. The meter selected should give a good deflection for an applied potential of 0.3 volt.

Use a 400 cc. beaker as the titrating vessel. Place it on a small board fastened to a ring supported by a ring-stand. The ring should be about five inches from the base of the stand. Now arrange the stirrer and electrodes. The latter

4. Ind. Eng. Chem., Anal. Ed., **7**, 341 (1935).
5. Ibid. **8**, 144 (1936). Cf. correction on page 180 of the same volume.

should be about an inch from the bottom of the beaker. A buret is mounted so that it will drain into the beaker. With this arrangement samples may be changed by simply lowering the ring, and it will not be necessary to disturb the rest of the equipment. Adjust the stirrer speed so that 300 cc. of water in the beaker will be stirred as rapidly as possible without splashing.

Measure exactly 5.00 cc. of the sample into the beaker and add 100 cc. of water. Ignoring the meter for the present, start the stirrer and titrate slowly with 0.1*N* silver nitrate until a faint turbidity develops. This is the free cyanide end-point and the volume of silver nitrate used should be recorded. At this point add 200 cc. of water and slightly more 5% barium nitrate solution than is necessary to precipitate the carbonate present (1 cc. of $BaNO_3$ solution will take care of 0.5 oz./gal. of Na_2CO_3). Run in an amount of silver nitrate equal to that already used. Now watch the meter and slowly continue the titration. The potential will remain quite constant as the silver nitrate is added until the end-point is approached then it will begin to rise. The end-point is indicated by a sudden and marked *decrease* in potential. The silver content of the solution being analyzed is then calculated in exactly the same manner as described above for the indicator method.

It is particularly important that the electrodes be electrically clean, otherwise their behavior will be erratic. The tungsten electrode is cleaned by dipping the wire into fused sodium nitrite (it should be just hot enough to stay molten). After cooling, rinse off the frozen nitrite. Repeat if necessary to obtain a bright surface. The platinum should be clean and bright to start with and it is then heated to redness in a non-luminous flame until it no longer colors the flame. If trouble is encountered with the titration, it is almost invariably due to contaminated electrodes.

Silver cyanide will precipitate on the stirrer and electrodes during the titration. It can be readily removed by raising a beaker of 10% cyanide solution around the coated parts. This treatment must be followed by a thorough rinsing with water to insure the complete removal of all the cyanide.

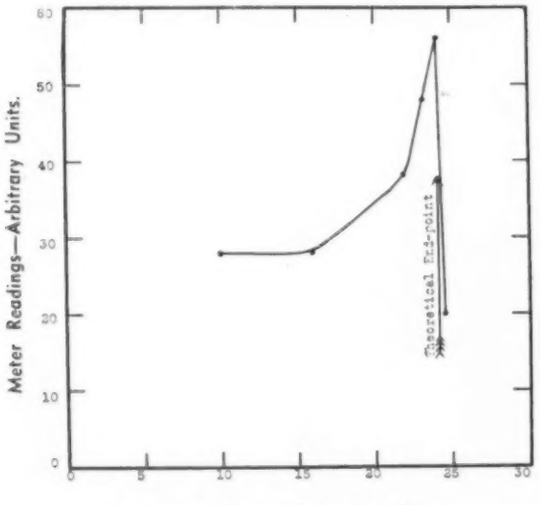

Fig. 1. Meter readings vs. volume of silver nitrate used in the titration. The arbitrary units in which the meter readings are expressed are proportional to the actual potentials.

Discussion of the Potentiometric Method

The potentiometric method is attractive for two reasons: (a) only one sample is needed for both the free cyanide and the silver determination, (b) the rise in potential near the end-point serves as an excellent warning sign. These advantages help balance the special equipment which is required.

Objections may be raised to the titration of free cyanide without having potassium iodide present as an indicator. It is true that the end-point is somewhat more difficult, but the results are sufficiently accurate for routine work. The addition of potassium iodide to the solution is, of course, impossible since silver nitrate would be used to precipitate silver iodide before the end-point was reached. A known amount of iodide might be added and a suitable correction made, but this idea has not been investigated since it seemed an unnecessary complication.

Fig. 1 shows a typical curve obtained when meter readings are plotted against the volume of silver nitrate added. The sharpness of the end-point is well illustrated. The arrow indicating the theoretical end-point will serve as an indication of the accuracy which may be expected of the method. In general, however, it is not quite as accurate as the indicator method, but more than good enough for routine control work.

It must be pointed out that "strike" solutions cannot be analyzed by this method. The end-point is not at all well defined when such solutions are titrated by the potentiometric method.

Addition Agents in Nickel Plating

(*Concluded from page* 611)

TOLUALDEHYDE—$C_6H_5CH_2CHO$

Slightly soluble, promotes adhesion, but has no noticeable brightening effect.

TIN TETRAPHENYL—$(C_6H_5)_4Sn$

Almost insoluble—darkens plate slightly, eventually causes small blisters in a partially bright deposit.

TOLUENE—$C_6H_5CH_3$

Very slightly soluble, excess floats on solution and interferes with regular deposit surface.

TOLUANILIDE—$C_6H_5CH_2CONHC_6H_5$

Insoluble in acid solution, excellent brightening effect.

TOLUIC ACID—$C_6H_5CH_2COOH$

Soluble up to 16 ounces per gallon, some brightening effect but deposit becomes dark on continued electrolysis.

TROPIC ACID—$C_6H_5CH(COOH)CH_2OH$

Soluble, but forms gummy substance which adheres to cathode at once.

There are a number of other similar compounds which have been prepared but not tried as yet. Among these are:

CALCIUM CITRATE—$(C_6H_5O_7)_2Ca_3 \cdot 4H_2O$

COBALT CITRATE—$(C_6H_5O_7)_2Co_3 \cdot 2H_2O$

IRON CITRATE—$(C_6H_5O_7)Fe \cdot 3H_2O$

MERCURY BENZOATE—$(C_6H_5COO)_2HgCOH$ (?)

DIBENZYLDIETHYLSTANNANE—$(C_6H_5 \cdot CH_2)_2Sn(C_2H_5)_2$

TRIPHENYL AMINE—$(C_6H_5)_3N$

XENYL AMINE—$C_6H_5C_6H_4NH_2$

Electro-Tinning of Parts to Be Soldered†

By C. E. HOMER, B.Sc., Ph.D., and H. C. WATKINS

The difficulties associated with the soldering of electro-tinned parts have in the past been unsurmountable, but in this article the authors, by investigation of the factors involved, are able to give instructions by following which successful soldering may be carried out. They conclude that the thickness of the deposit is the dominant factor and recommend minimum thicknesses for particular metals.

MANY articles are coated with tin in order to enable them to be soldered easily with non-corrosive fluxes such as rosin. Hot-dipping is generally used for this purpose, but there are many articles for which this method of tinning is inconvenient and uneconomical. As an example, the small tags and clips used in electrical and telephone work may be mentioned. They frequently have to be dipped one at a time in the molten tin, and due to difficulties in handling, the finish is often poor. Electro-tinning is a much more convenient method for articles of this type, since a large number may be plated together in a basket or barrel without fear of them sticking together.

The use of electro-tinning for parts to be soldered has been restricted, however, by difficulties which are sometimes encountered in soldering this type of coating. The solder refuses to flow or to alloy with the tin coating, and gathers into drops, rather like water on a greasy surface. The strength of the resulting joint is low, and the speed of working is considerably reduced. Occasionally, the trouble is so pronounced that it is necessary to remove the tin coating by abrasion before soldering can be effected. These difficulties sometimes occur with freshly-plated surfaces, but in many cases they do not arise to a serious extent unless the articles have been stored for a few weeks or heated before soldering. During storage or heating they acquire a slight bluish colour and soldering is then found to be very difficult. The trouble most frequently occurs with coatings from the old stannous chloride bath, which is liable to give loose powdery deposits, but is also encountered with sound coatings from the modern stannate and acid sulphate baths.

Prejudice against Electro-tinning as Basis for Soldering

As a result of these experiences there is a considerable amount of prejudice against the use of electro-tinning as a basis for soldering. The authors have, however, met with a number of instances where electro-tinned parts are being regularly soldered at least as easily as hot-tinned parts, showing that an electro-deposited tin coating is not necessarily difficult to solder. An investigation has therefore been carried out in order to discover the causes of these differences in soldering properties, and to establish the conditions for obtaining consistently good results.

Remedies Previously Suggested

Although there has been no published research on this particular soldering problem, it has been investigated to some extent, and one or two remedies have been suggested.

It is generally considered that the trouble is due to oxidation of the coating, and this view appears to be supported by the bluish discoloration which often develops on electro-tinned articles. The oxidation of the coating has been attributed to two principal factors:—

(1) The greater reactivity of the matt surface compared with the bright finish of the hot-dipped coating.

(2) Corrosive residues of plating solutions left on the surface due to insufficient washing after plating.

The remedies which have been suggested are based upon the above explanation; they involve more thorough washing after plating and some form of mechanical treatment to remove or consolidate the reactive surface layer. Wet scratch-brushing is often used, while a patented process (British Patent 434,103) consists in rumbling the parts with steel balls and soap-suds immediately after plating. The use of a corrosive flux (*e.g.*, zinc chloride) instead of rosin is also suggested for some types of work. None of these expedients has proved to be more than a partial remedy for the trouble.

Experimental

In the series of experiments described below, electro-deposited tin coatings of different types were subjected to various treatments and the effects on the soldering properties were determined. The modern stannate and acid tin-plating baths were used, in order to avoid the complications due to the powdery deposits sometimes obtained from the stannous chloride bath.

The soldering properties were evaluated by spreading and soldering tests. For the spreading test a piece of electro-tinned sheet (copper, brass or steel), 1.5″ square, was painted over with a 20 per cent solution of rosin in wood alcohol and a small piece of 50-50 solder wire, dipped in the same rosin solution was placed in the center. The specimen was gently heated from above with a gas flame until

† Reprinted from *The Metal Industry* (London), Jan. 3, 1941.

the solder melted, and when the latter had spread as far as it was able, the flame was removed. Rosin was used as a flux since it is commonly employed for tinned copper, (and, being a relatively weak flux, it makes it easier to differentiate between specimens of good and bad soldering quality. Pieces of solder of the same size were used for all the experiments, and all tests were made in triplicate. The results were very consistent.

The soldering quality was judged by inspection of the diameter of the solder drop after spreading and the angle of contact between the solder and the tinned surface. The difference between good and bad spreading was sufficiently pronounced to enable the results to be evaluated without quantitative measurements. Typical specimens are illustrated in Fig. 1. As a further check, a parallel series of soldering tests were also carried out. Lap joints were made with a soldering iron between strips cut from the same specimens of electro-tinned sheet in order to determine the ease of soldering from a practical point of view. The results in all cases supported those obtained from the spreading tests. The soldering test, however, proved less sensitive than the spreading test in detecting small differences between the specimens. For one short series of spreading tests, the specimens were heated in a furnace and measurements of the contact angles were made by the method of Chalmers and Wadie.[2] The results confirmed those obtained by inspection of similar specimens heated as described above.

Influence of Washing and Scratchbrushing after Plating

Pieces of copper sheet were plated with 0.0001″ of tin from the stannate and the acid sulphate baths, and specimens cut from them were treated as follows, three spreading and three soldering test specimens from each bath being subjected to each treatment:—

(1) Well rinsed in a beaker of water and then in running water. Spreading and soldering tests carried out immediately.

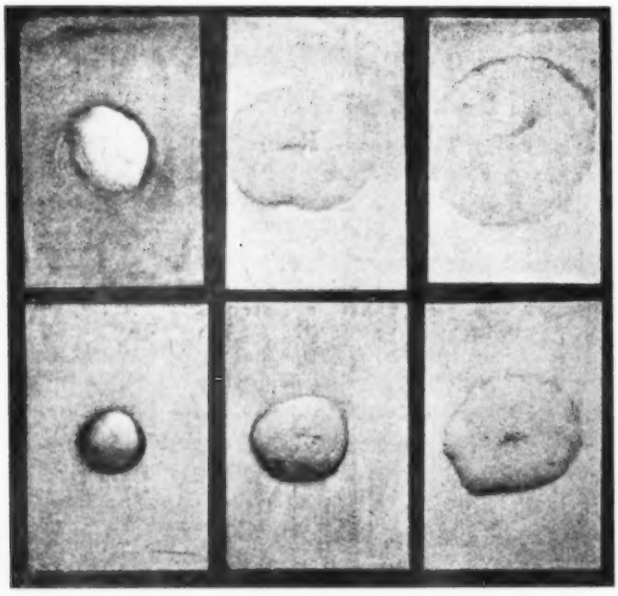

Fig. 1. Examples of the spreading of solder.

(2) Quickly rinsed in a beaker of water only. Tested immediately.

(3) Well rinsed and wet scratch-brushed. Tested immediately.

(4), (5) and (6). Prepared as in (1), (2), and (3), but heated for one hour at 170° C. before testing.

(7), (8) and (9). Prepared as in (1), (2), and (3), but stored in a cupboard for 6 weeks before testing.

All these specimens had good soldering qualities and the differences between them were insignificant.

Importance of Thickness of Coating

Since many electro-tinned articles which have been difficult to solder have had extremely thin coatings, it appeared that the thickness of deposit might be the controlling factor.

The effect of thickness was investigated by means of spreading and soldering tests on copper specimens plated with 0.00001″ and 0.00005″ of tin from the stannate and acid baths. These were well washed after plating, and some were tested at once and others after storage for 6 weeks. The results were compared with those given by the corresponding specimens with a coating of 0.0001″ described above.

The specimens which were tested immediately showed marked differences in behaviour. Spreading and soldering were good in the case of the specimens with a coating of 0.00005″ or 0.0001″, but bad with 0.00001″. It was also noticed that the thinnest coating became bluish in appearance when heated during the test, while the appearance of the others did not change. After storage there was a greater difference between the three thicknesses of coating. Very bad results were obtained with 0.00001″, which had become bluish in appearance during storage, and poor results with 0.00005″. With 0.0001″, the ease of soldering was not appreciably diminished, although a very slight deterioration was observed in the more sensitive spreading test. A few specimens with a coating of 0.0001″ were kept for 14 weeks before testing, and after that period the spreading test showed a little further deterioration, but not enough to have a serious effect on the ease of soldering.

Specimens of electro-tinned brass and steel sheet were subjected to the same tests, and were found to give similar results. The brass specimens were plated with 0.00005, 0.0001, and 0.0002″ of tin, while the coatings applied to the steel were 0.000005, 0.00001, 0.00005, and 0.0001″. In both cases, spreading and soldering tests were carried out immediately after plating and also after storage. The results indicate that for brass a minimum coating thickness of approximately 0.00008″ is required for immediate soldering and 0.00015″ for soldering after storage for 6 weeks. The corresponding figures for steel are about 0.00005 and 0.00008″, respectively.

Since it may sometimes be desired to sweat together electro-tinned surfaces, without applying solder, the minimum thickness required for this purpose was determined. The test employed consisted in pressing together with a hot soldering iron the overlapping ends of two flat pieces of electro-tinned copper sheet. It was found that at least 0.0005″ of tin is necessary in order to provide a sufficient amount of tin to give good adhesion and fill the joint properly. This is similar to the thickness applied by hot

dipping. It was not possible to sweat the surfaces together satisfactorily without using a flux, but rosin was sufficiently active to give good results.

Importance of Type of Plating Bath Used

Since the thickness of the coating is the principal factor in determining the ease of soldering, it is important to be able to control it accurately.

With the stannous chloride solution, the thickness of deposit has little relation to the time of plating. The tin is deposited normally for a certain time and then in many cases deposition practically ceases, so that after several hours the coating is still very thin. In other instances, the deposit becomes loose and spongy if attempts are made to thicken it. The loose coatings always solder badly, and since the sound ones are nearly always below 0.0001″ in thickness, their soldering qualities are uncertain. Some which have been examined have been as thin as 0.00002″ and have been unsatisfactory even when freshly deposited, while the average thickness seems to be about 0.00005″. Sometimes, when the bath is working well, sound coatings of 0.00008-0.0001″ may be obtained, but these are not common. A further difficulty with this bath is that when large additions of glue have been made of it, the deposits contain an appreciable amount of organic matter, which also tends to inhibit soldering.

These difficulties and uncertainties are not encountered when the stannate and acid sulphate baths are employed, since the thickness of the deposit can be accurately controlled. The stannate bath is very suitable for the basket plating of small parts, and the acid bath for barrel plating. Either may be used for the plating of larger articles suspended individually in the bath.

Mention should be made of the boiling or chemical replacement methods of tinning which are sometimes used for small articles. The coatings produced by these methods are generally extremely thin (less than 0.00001″) and are therefore not recommended for parts to be soldered.

Conclusions and Recommendations

Electro-tinned copper, brass, and steel may be soldered without difficulty, using a rosin flux, provided that the coatings are sound, adherent, and of adequate thickness. No surface treatment after plating is required. The thickness is of particular importance, and unless it exceeds a certain minimum figure, satisfactory soldering is impossible; insufficient thickness is the cause of practically all the difficulties encountered in soldering electro-tinned surfaces. These difficulties have previously been attributed to oxidation of the coating, which is now shown to be of little importance.

It seems most probable that the difficulty of soldering the thin coatings is due to the diffusion of the tin into the base metal. A thin deposit is soon lost in this way, but with a thicker coating, only a fraction of the thickness becomes alloyed with the base metal, the tin at the outer surface remaining unchanged. The fact that the rate of deterioration of thin coatings during storage depends on the nature of the base metal gives further support to this explanation.

The limiting thickness of electrodeposited tin below which soldering troubles are encountered, has been determined for the three base metals. Since there is generally some variation of coating thickness when articles are plated on an industrial scale, it is recommended that the minimum average thicknesses adopted should be at least 50 per cent higher than these limiting figures. Assuming about 6 weeks between plating and soldering, consistently good results should be obtained with 0.00015-0.0002″ on copper, 0.0002-0.00025″ on brass, and 0.0001-0.00015″ on steel. These coatings allow some latitude in case storage is occasionally somewhat prolonged, but if very long periods of storage are expected it is desirable to increase them a little, say by 50 per cent. The recommendations refer to coatings which are applied only for the purpose of facilitating soldering. If good protection from corrosion is also required, a greater thickness will probably be needed.

Further soldering tests, using rosin as flux, have been made on specimens of brass, copper and steel which were electro-tinned in our laboratories upwards of two years ago. The results fully confirmed our previous conclusions: it was found that the minimum thickness of tin necessary for successful soldering depended upon the base metal and upon the time of storage, and was generally less than the thickness normally applied by hot-dipping. Even with specimens stored for six years there was no deterioration due to oxidation or tarnishing, and the soldering properties depended entirely upon the thickness of the tin coating.

RECOMMENDED MINIMUM THICKNESSES OF ELECTRO-TINNED COATINGS FOR SOLDERING

	Storage up to 6 weeks		Storage up to 2 years	
Base Metal	inch	mm.	inch	mm.
Brass	0.0002	0.005	0.0005	0.0125
Copper	0.00015	0.004	0.0003	0.0075
Steel	0.0001	0.0025	0.0002	0.005

This work was carried out in the laboratories of the Tin Research Institute. The authors are indebted to the International Tin Research and Development Council for permission to publish the results.

References

1. For details, see Publication No. 92 of the International Tin Research and Development Council.
2. J. Inst. Metals **66**, 241 (1940).

New Aluminum Deposits

A large deposit of alunite near Quartzsite, Ariz., may be worked in the near future to relieve to some extent the aluminum shortage.

It is reported that engineers of the *Reynolds Metal Co.* are expected shortly to begin inspection of the deposit. The alunite was found a number of years ago by the Ropp brothers, Arizona prospectors.

The deposit is reported to contain 36% aluminum. Whether impurities are present which would make it difficult to work awaits metallurgical determination.

Until recently, bauxite was the only commercial ore of aluminum. The alunite is to be reduced by a recently perfected reduction method. Proximity of the alunite to Parker at the Colorado River in western Arizona, where a large hydro-electric generating plant is being built for the U. S. Bureau of Reclamation, is cited as one of the advantages in favor of the Ropp deposit. It is pointed out that the electricity required to recover the aluminum is right at hand, or will be by the time a plant can be built.

Fundamentals of Science Relating to Electroplating

Chapter XII. Faraday's Laws

Every plater realizes that what happens at either electrode is not at all simple, except in a few rather unusual and infrequent cases. In fact, he must often think that to a certain degree much of what happens, and the degree to which it happens, is helter-skelter and unpredictable and that it is surprising that more imperfect results and less consistency are not obtained than at present. Yet, although the processes are complex and not simple, they are controlled by immutable laws and, if we only had sufficient data and knowledge, they could be calculated with high precision.

One example of the above is the familiar fact that, in a given solution and perhaps under definite conditions, the actual weight of a deposit electroplated with a given current for a given time can be predicted very accurately. The basis for this calculation is one of the fundamental principles of electroplating, for which credit is due again to that pioneer of science, Michael Faraday. The date is again approximately 100 years ago, namely, in 1834, and the statements governing the above comprise the two famous Faraday laws.

The *First Law of Faraday* states that the quantities of substances set free at the electrodes, such as electrodeposits or dissolved metal, are in direct proportion to the quantity of electricity (that is, the number of coulombs) which has passed through the solution. It will be recalled that coulombs are obtained by multiplying amperes by time, so that in effect the above states that the quantities of substances liberated at the electrodes are proportional to the current and time. Double the time and the weight of deposit is doubled. Triple the current, and the weight dissolved from the anode is tripled. Double the time and the current, and four times the weight of deposit is obtained, four times the weight of gas is liberated, four times the weight of metal is dissolved at the anode, and so forth—the examples can be given indefinitely.

The *Second Law of Faraday* goes one step further. It states that, in addition to the above, the actual weights of substances set free are proportional to their chemical equivalents. The chemical equivalent of a substance is its atomic weight divided by the valence change in the reaction. The chemical equivalents of the common metals are given in the 3rd column of Table VIII. Under ideal conditions, the same quantity of electricity which sets free 1 gram of hydrogen would also set free 56 grams of cadmium, 29.3 grams of nickel, 8 grams of oxygen, 32.5 grams of zinc, 107.9 grams of silver, etc.

In a previous chapter it was stated that one coulomb could deposit, by definition, 0.001118 gram of silver. To deposit 107.9 grams of silver would therefore require 107.9 divided by 0.001118 or 96,500 coulombs. Above it was said that the same quantity of electricity that liberated 107.9 grams of silver could also liberate a chemical equivalent weight of any substance. Therefore, 96,500 coulombs, which are the same as 96,500 ampere-seconds, will liberate one chemical equivalent weight of any substance. This figure is called a *Faraday*. Another term that is very convenient is the *electrochemical equivalent*. This is obtained by dividing the chemical equivalent by 96,500. The result is also of course, the number of grams of a substance set free by one coulomb. Column 4 of Table VIII gives the electrochemical equivalents of the common metals.

It will be noted, that in some of the examples of electrodeposited weights cited above, the expression "under ideal conditions" was used. This is because in most cases, the duties of the current are multifold, that is for example, part of the current may be used for depositing metal and part for "plating" hydrogen. Even here, however, the laws are rigidly followed. For example, assume a current of 100 amperes flowing for 1000 seconds. One hundred thousand (100,000) coulombs of electricity are involved. Assume further that 90% of the current is engaged in plating nickel and the other 10% in plating hydrogen. Then 90,000

$$\text{coulombs or } 0.93 = \frac{90{,}000}{96{,}500} \text{ Faradays}$$

$$\text{will set free nickel and } 0.07 = \frac{10{,}000}{96{,}500}$$

Faradays will liberate hydrogen. Since the chemical equivalents are respectively 29.3 and 1, there will be set free $0.93 \times 29.3 = 27.3$ g. of nickel and $0.07 \times 1 = 0.07$ g. of hydrogen. We say in such a case that the *cathode current efficiency* for plating nickel was 90%.

On the other hand, to determine the cathode current efficiency of any process, such as the plating of nickel, it is necessary to know how much metal has been plated in a given time with a given current, or if either of these vary, what the total quantity of electricity was used. For example, assume that a current of 200 amperes flows for 10 minutes and that 34.2 grams of nickel are deposited. What is the cathode current efficiency for plating nickel?

Solution of problem:

$10 \times 60 = 600$ seconds

$200 \times 600 = 120{,}000$ coulombs or ampere-seconds

From Table VIII, the electrochemical equivalent of nickel is 0.000304 gram per ampere-second

$120{,}000 \times 0.000304 = 36.5$ grams nickel deposited theoretically

Then:

$$\frac{\text{actual deposit}}{\text{theoretical deposit}} \times 100 = \frac{34.2}{36.5} \times 100$$

$= 93.7\%$ cathode current efficiency

Several other typical problems may now be solved to illustrate further the above.

Problem: A certain cadmium plating solution is known to have a cathode current efficiency of 92%. The total area of the work being plated has been computed to be 5.5 sq. ft. The current density recommended is 25 amperes per sq. ft. If it is desired to secure a minimum thickness of 0.001 inch of cadmium, how long must the work be plated? Assume that a 15% excess will be necessary to secure the minimum thickness because of lack of uniformity in plating.

Solution to problem: (Note: Tables are often available which give the answers to such problems very conveniently. They are deliberately omitted at this time to permit illustration of Faraday's Laws by actual computation of the desired values.)

Refer to Table VIII

Using column 6: 0.001 in. cadmium requires $\frac{0.00100}{0.00139} = 0.719$ oz./sq. ft.

For 5.5 sq. ft.: $0.719 \times 5.5 = 3.95$ oz. cadmium total required.

Using column 5: $\frac{3.95}{0.0739} = 53.6$ amp.-hr. of electricity needed to plate 3.95 oz. at 100% current efficiency.

$53.6 \times 60 = 3216$ amp.-min. needed.

At 25 amp. per sq. ft., need $25 \times 5.5 = 138$ amp. total current.

$\frac{3216}{138} = 23.4$ minutes needed at 100% current efficiency.

$\frac{23.4}{0.92} = 25.4$ minutes needed at 92% efficiency.

If the cadmium deposited absolutely uniformly, the required thickness would be secured in 25.4 minutes under the non-varying conditions stated above. Since, however, the latter is an ideal and not an actual condition, assume that a 15% excess, as stated in the problem, has been shown by experience to be sufficient to insure a minimum thickness of 0.001 inch. The total time required will therefore be 25.4 x 1.15 = 29.2 minutes.

It is also possible to compute in the above problem how much hydrogen will be liberated. The extra time needed due to the

efficiency being only 92% is consumed in liberating hydrogen. This time is 25.4 — 23.4 = 2.0 minutes.

At a current of 138 amperes, the above involves 2 × 138 = 276 amp.-min. 276 × 60 = 16,560 amp.-sec.

Using Table VIII, Column 4: 16,560 × 0.0000104 = 0.172 g. hydrogen liberated.

Since 1 g. of hydrogen has a volume of 22,200 cc. at standard temperature and pressure, there will be 22,200 × 0.172 = 3820 cc. or about 1 quart of hydrogen liberated.

This hydrogen represents a decrease of hydrogen ions in the solution near the cathode as will be discussed more fully later. The removal of hydrogen ions, we have seen, increases the pH of the solution. While in the case of cadmium this may not be serious, every plater realizes the importance of this in the case of depositing such metals as nickel. Furthermore, 1 quart of hydrogen represents many bubbles of gas and each bubble is a potential pit if it sticks to the cathode surface too long. It is evident, therefore, that a high cathode current efficiency is desirable not only because of economic power consumption and fast plating, but also because it minimizes the danger of poor deposit.

Let us suppose in the above problem that the anodes dissolve with an anode current efficiency of 95% and that the solution, comprising 200 gallons, is operated 30 hours per week. What will be the metal situation, in the solution, at the end of a week, neglecting drag-out?

Solution to problem:

At a total current of 138 amp., the total electricity used per week is 138 × 30 = 4,140 amp.-hours.

At 100% current efficiency at both the anode and cathode, this would mean (from Table VIII)

0.0739 × 4,140 = 306 oz. of cadmium plated at the cathode and dissolved at the anode.

At a cathode current efficiency of 92%, only 306 × 0.92 = 282 oz. of cadmium actually were deposited.

At an anodic current efficiency of 95%, 306 × 0.95 = 291 oz. of cadmium were dissolved.

The solution, over a week's time, has therefore gained 291 — 282 = 9 oz. of cadmium.

If drag-out losses did not exist (or all drag-out was returned to the plating bath) the solution would increase $\frac{9}{200} = 0.045$ oz./gal. in cadmium. Actually, however, this potential increase only helps to offset the effect of the drag-out.

In the entire discussion above, it has been assumed that the current was constant over the plating period so that the total electricity involved could be computed by multiplying the current by the time. In practice, however, the current fluctuates slightly, depending upon the source of the electricity and the variation in load on the line.

For the base metals such as cadmium, zinc, nickel and copper, slight inaccuracies in the weight of deposits resulting from such current variations are not very important. In the case of precious metals, however, the situation is quite different. Here either the buyer or the vendor of the plated goods suffers a financial loss if the weights are not accurate. In the case of precious metals, therefore, automatic devices are used, which mechanically compute and register the exact quantity of electricity consumed, correcting automatically for current fluctuations. These instruments are called *ampere-hour meters* and since, as we have seen, ampere-hours can be converted into weight of deposit, these meters really measure the weight of deposit being applied. They can be so arranged that when a given quantity of metal has been deposited, a switch is automatically opened and further plating is stopped. The biggest use for ampere-hour meters is in the silver plating industry.

TABLE VIII

Name of Element	Chemical Symbol	Equivalent Weight	Electro-chemical Equivalent in grams per amp.-sec.	Electro-chemical Equivalent in ounces per amp.-hour	Thickness in Inches of 1 oz./sq. ft.*
Antimony	Sb	40.6	0.000421	0.0534	0.00180
Arsenic	As	25.0	0.000259	0.0329	0.00210
Cadmium	Cd	56.2	0.000582	0.0739	0.00139
Chlorine	Cl	35.5	0.000367	0.0466	
Chromium	Cr	8.7	0.000090	0.0114	0.00169
Cobalt	Co	29.5	0.000305	0.0388	0.00135
Copper (acid)	Cu	31.8	0.000329	0.0418	0.00134
Copper (cyanide)	Cu	63.6	0.000659	0.0837	0.00134
Gold	Au	197.2	0.00204	0.0259	0.00062
Hydrogen	H	1.01	0.0000104	0.00132	
Iron (ferrous)	Fe	27.9	0.000289	0.0367	0.00153
Lead	Pb	103.6	0.00107	0.0136	0.00106
Nickel	Ni	29.3	0.000304	0.0386	0.00135
Oxygen	O	8.00	0.0000829	0.0105	
Palladium	Pd	26.7	0.000277	0.0352	0.00099
Platinum	Pt	48.8	0.000506	0.0644	0.00056
Rhodium	Rh	34.3	0.000355	0.0451	0.00097
Silver	Ag	107.9	0.00112	0.0142	0.00114
Tin (alkaline)	Sn	29.7	0.000308	0.0391	0.00164
Tin (acid)	Sn	59.4	0.000616	0.0782	0.00164
Tungsten	W	30.7	0.000318	0.0404	0.00064
Zinc	Zn	32.7	0.000339	0.0423	0.00168

*Most of the values in this column were taken from "Plating and Finishing Guidebook," 1941 Edition published by Metal Industry Publishing Co., New York, N. Y., which contains many pertinent data.

Patent Digest

Apparatus for Electrochemical Analysis

U. S. Pat. 2,246,981. L. A. Matheson, N. B. Nichols, H. A. Robinson and C. F. Du Chene, assignors to The Dow Chemical Co., June 24, 1941. Apparatus for electrochemical analysis comprising means for containing a solution to be analyzed, a reference electrode and an indicating electrode disposed to contact said solution, means for impressing a recurrent substantially linear voltage sweep across said electrodes giving rise to a varying flow of current therebetween, and indicating means immediately responsive to the variations in said current.

Vitreous Enamel

U. S. Pat. 2,249,007. C. J. Kinzie and C. H. Commons, assignors to The Titanium Alloy Mfg. Co., July 15, 1941. A method of making white vitreous enamel ware with coatings less in weight than 40 grams per square foot and having a reflectance above 70 and substantially greater than that produced with the frit used and clay alone, which comprises milling a mixture of a white frit 100 parts by weight having a basic reflectance above 60, clay, water and not less than 10 parts by weight of an opacifier selected from the dioxides of the group consisting of zirconium, tin, titanium, hafnium, thorium and cerium, said mixture being ground to a fineness where more than 95% of the particles are less than 44 microns in size to form the enamel slip, applying the said slip to ground coated ware in a thin film not exceeding 40 grams per square foot when fired, and burning the slip coated ware at firing temperatures to produce said adherent vitreous enamel ware.

Buffing Compound Applicator

U. S. Pat. 2,251,161. C. I. Packer & E. H. Kammerer, assignors to The Packer Machine Co., July 29, 1941. An automatic device for applying buffing compound to buffing wheels on an automatic polishing machine.

Buffing Compound

U. S. Pat. 2,246,554. R. V. Twyning, assignor to J. C. Miller Co., June 24, 1941. A buffing compound comprising finely divided abrasive material and a binder therefor of stearin pitch, said pitch being the residue remaining after the hydrogenation and distillation of animal or vegetable fats to remove stearic acid and glycerides.

Buffing Wheel

U. S. Pat. 2,251,690. C. J. Peterson and A. H. Peterson, August 5, 1941. An all paper buffing wheel with a plurality of superposed layers of radially crinkled paper.

Copper Bath

U. S. Pat. 2,250,556. J. E. Stareck, assignor to United Chromium, Inc., July 29, 1941. An aqueous bath for the electrodeposition of copper containing a copper pyrophosphate complex in which complex the pyrophosphate and copper are in the molecular weight ratio of 2:1 and having a pH between 7.5 and 9.5 and containing an excess of pyrophosphate.

Example:

Copper sulfate	200 g./l.
Sodium pyrophosphate	200 "
Sodium chloride	30 "

pH—8.3 (glass electrode); voltage—0.8 volt, temp. 95° F.; C.D., 10 amp./ft.²

Addition of radical from the class of citrate, carbonate, tartrate and oxalates gives bright deposits. Also small amounts of metallic compounds such as arsenic, bismuth, iron, chromium, tin, zinc, lead and cadmium.

Example:

Copper pyrophosphate	110 g./l.
Potassium pyrophosphate	404 "
Ammonia	3 "
Citric acid	10 "

pH—8.5 (glass electrode). Pyrophosphoric acid and potassium hydroxide (sodium hydroxide in the case of sodium solutions) are used for correcting the pH.
Temp.—120° F.; 0.8-1.5 volts. 5-50 amp./ft.²

Corrosion Prevention of Zinc

U. S. Pat. 2,250,508. J. S. Thompson & E. S. Hanson, July 29, 1941. A method of increasing the corrosion resistance of zinc surfaces by subjection to a solution composed principally of an acid of the group consisting of the aromatic series of acids having two carboxyl groups, the monocarboxylic acids of the aliphatic series, the tricarboxylic acids of the aliphatic series and the hydroxymonocarboxylic acids of the aliphatic series until a visible protective coating is obtained on the zinc surfaces. Also containing a metal accelerator in the form of a soluble compound of a metal from the group of iron, antimony, arsenic, zinc, cobalt, copper, nickel and cadmium.

Example:

Formic acid	2.5%
Ferric sulfate	1%

Immersion for 5 minutes at boiling. The coat is gray. If ½% of sodium nitrate is added a hard reddish coat is produced at room temperature in 5 min.

Example:

Propionic acid	2½%
Ferric sulfate	1%
Sodium nitrate	½%

A black color is produced at room temp. in 3 min.

Coloring Magnesium & Alloys

U. S. Pat. 2,250,473. H. K. DeLong, assignor to The Dow Chemical Co., July 29, 1941. The method of producing a corrosion resistant coating upon an article of magnesium and alloys which comprises subjection to the action of a solution of water and an alkali at temperatures between 150° C. and 250° C. and under a pressure at least equal to the vapor pressure of the solution at the operating temperature.

Example:

Sodium or lithium hydroxide	2-20% by weight
Dye	0.1-0.5% " "

Temp. 170-210° C. 5 min. immersion at 200° C.

A list of suitable dyes is given including Malachite Green, Methyl Red, Aniline Red, Methyl Orange, Bismark Brown, etc.

Grinding Wheel

U. S. Pat. 2,250,580. M. J. Gregory, assignor to Caterpillar Tractor Co., July 29, 1941. A cup type grinding wheel of novel design.

Plating Barrel Contact

U. S. Pat. 2,249,609. W. H. Jackson, assignor, by mesne assignments, to The Udylite Corp., July 15, 1941. A flexible contact for a plating cylinder to withstand bending stresses.

Porcelain Enamel

U. S. Pat. 2,250,456. M. J. Bahnsen & E. E. Bryant, assignors to Ferro Enamel Corp., July 29, 1941. A porcelain enamel frit of the character produced by smelting a raw batch mixture of the following composition:

	Per cent
Silica sand	2.85
Dehydrated borax	18.15
Feldspar	24.90
Zircon sand	19.30
Sodium nitrate	1.15
Fluorspar	4.55
Sodium fluosilicate	16.25
Bone ash	5.30
Aluminum hydrate	4.90
Zinc oxide	2.65

Electroformed Sheet

U. S. Pat. 2,250,435. E. O. Norris, assignor to Edward O. Norris, Inc., July 22, 1941. A matrix for production of electroformed foraminous sheet having an exposure surface which comprises a deposit-receiving area of grid pattern, the areas of which between the junction areas curve away from the plane of said crossing points to an archlike form, the planes in which the curves lie being normal to the surface of the matrix and the remaining portions of said exposure surface consisting of material that is passive to electrolytic deposition.

Corrosion Prevention of Magnesium

U. S. Pat. 2,248,062. R. W. Buzzard, July 8, 1941. A method of producing corrosion resisting films on magnesium and high magnesium alloys, comprising anodizing and then subjecting the anodized film to immersion in an aqueous solution of a soluble trivalent chromium salt and a water soluble compound selected from the group consisting of chromate and dichromate.

Example:

Zinc chromate	1-3%
Chromium fluoride	3-7%

Solution should be on the acid side and at boiling temperature.

Example:

Sodium dichromate	10%
Monobasic sodium phosphate	10%
Chromium fluoride	1%

Example:

Zinc chromate	1%
Sodium dichromate	5%
Chromium fluoride	1%

Coloring Aluminum

U. S. Pat. 2,247,580. O. Jauch, assignor to Robert Bosch Gesellschaft (Germany), July 1, 1941. A process of producing black-colored corrosion resisting layers on the surface of aluminum and aluminum alloys, consisting of preliminary treatment with an aqueous solution of aluminum chloride at elevated temperature, then coloring in a heated potassium permanganate solution acidified with sulfuric acid, and then subjecting it to an after treatment by immersion in an alkaline chromate solution at elevated temperature.

Examples:
First Bath:

Aluminum chloride	20-30%

Temperature 60-70 ° C. Time 1-5 min.
Second Bath:

Potassium permanganate	40-80 grams
7% sulfuric acid	1 liter

Temperature—approx. 60° C.
Third Bath:

Sodium carbonate	30-80 grams
Sodium chromate	10-20 "
Water	1 liter
Temperature	95-98° C.
Time (approx.)	10 min.

Electroforming Screen

U. S. Pat. 2,250,436. E. O. Norris, assignor to Edward O. Norris, Inc., July 22, 1941. A matrix for the electrolytic production of foraminous sheet, comprising a nickel plate provided in its surface with a multitude of pits having constricted orifices, said pits being lined with copper, the said copper being partially enclosing a solid body of material passive to electrolytic deposition, the thickness of the copper lining being great enough so that in its absence the said solid body may pass without disintegration from said pits through said orifices.

Corrosion Prevention of Magnesium

U. S. Pat. 2,248,063. R. W. Buzzard, July 8, 1941. A method of producing corrosion resisting films on magnesium and high magnesium alloys, comprising anodizing and then subjecting the anodized film to immersion in an aqueous solution of a water soluble borate and a water soluble compound selected from the group consisting of chromate and dichromate.

Example:

Soluble dichromate	8-12%
Sodium borate	3- 7%

Solution should be on the acid side.

Example:

Sodium dichromate	10%
Sodium borate	5%

Purifying Plating Baths

U. S. Pat. 2,248,092. J. Korpiun (Germany) assignor to Sherka Chemical Co., Inc., July 8, 1941. A method for regenerating used electroplating baths, comprising bringing said bath into contact with inert solid adsorption materials of large specific surface capable of adsorbing gases and thereafter electrolyzing said bath. Nickel carbonate and water glass may also be added with the above.

Example:

To 100 liters of used nickel plating bath, add a mixture of 2.5 kg. of fullers earth, 0.3 kg. of nickel carbonate and 0.2 kg. of pulverized water glass, while stirring thoroughly. After settling, the clear bath is decanted and the remainder filtered. Or use 0.2 kg. of activated charcoal instead of 2.5 kg. of fullers earth.

Example:

To 100 liters of used acid copper bath add either 1.0 kg. of pulverized silica gel or 2.5 kg. of granular silica gel. Stir thoroughly and filter or decant. Treatments may be carried out at ordinary operating temperature of the solution.

Coloring Magnesium & Alloys

U. S. Pat. 2,250,472. H. K. DeLong, assignor to The Dow Chemical Co., July 29, 1941. Production of a colored corrosion resistant coating on magnesium and alloys which consists of subjection to a solution of water and a base selected from the class consisting of the soluble alkali and alkaline earth metal bases and a dye soluble in the solution, said step being carried out under a pressure of at least 20 pounds per sq. in. and at a temperature above the normal boiling point of the solution:

Example:

Sodium or lithium hydroxide or soda ash	2-20% by weight
Soluble dye	0.1-0.5% " "

Temp.—110-250° C. approx. and 20-400 lb./sq. in. pressure.

Duration 1-30 min. (5 min. at 200° C.). A list of suitable dyes is given including Malachite Green, Methyl Red, Aniline Red, Methyl Orange, Bismark Brown, etc.

Anti-Pitter

U. S. Pat. 2,254,161. V. H. Waite and B. P. Martin, assignors to The McGean Chemical Co., August 26, 1941. In nickel plating an addition agent comprising a sulfuric ester of a normal primary aliphatic alcohol having from 8 to 18 carbon atoms in the molecule. Or an alkali metal salt of a sulfuric derivative of at least one of the following alcohols: lauric, myristic, cetyl, stearic. Also with an organic brightener of the aryl sulfonic type.

Example:

Singel nickel salts	40 oz./gal.
Nickel chloride	4 "
Boric acid	4 "
Betanaphthalene monosulfonic acid	0.26 "
Technical sodium lauryl sulfate	0.26 "

pH — 2.5 Temp. — 105° F.
Current density = 50 amp./sq. ft.

Tin Deposition

U. S. Pat. 2,253,865. D. L. Ogden and M. F. W. Heberlein, assignors to The American Metal Co., Ltd., August 26, 1941. An electrolytic process for depositing tin without the necessity for interruption of the operation comprising electrolyzing an acidified aqueous solution of tin tetrachloride containing approximately 45 to 120 grams of hydrochloric acid per liter of said solution and at least approximately 30 grams of tin per liter of solution to effect deposition of the tin while forming chlorine and hydrochloric acid, the said concentration of hydrochloric acid in the electrolyte being maintained by maintaining the solution at a temperature of about 80° F. to 100° F., by adding tin chloride from time to time and by removing chlorine from the solution. Cresylic acid and glue may be present. The solution should contain not more than 1 g./l. of chlorine. Carbon anodes impregnated with linseed oil, paraffin, etc., are employed with a cathode current density of about 30 amp./sq. ft.

Corrosion Prevention

U. S. Pat. 2,250,842. S. T. Roberts (England), July 29, 1941. A process for protecting a metal article against corrosion, comprising electrically depositing thereon a ternary alloy containing zinc, cadmium and mercury in which the cadmium to zinc ratio is approximately 1:1, from an aqueous alkaline cyanide bath containing at least about 12 ounces of caustic soda per gallon of water and containing aluminum sulfate in solution in addition to the metal ions of the alloy being deposited, and employing an alloy anode containing zinc, cadmium and mercury, the zinc-mercury ratio of the anode being about 8:1 and the zinc-cadmium ratio thereof being about 2:1.

A current density of 10-25 amp./sq. ft. for 10 minutes gives a satisfactory deposit. It is preferable to anodize the article for a few moments before plating, using the plating solution for this purpose.

Example:

Sodium cyanide	12 oz.
Sodium hydroxide	12 "
Zinc sulfate	10 "
Cadmium sulfate	4 "
Mercuric chloride	2 "
Potassium aluminum sulfate	3.5 "
Dextrine	2 "
Glycerhyzine (ammoniated glycerine)	1.25 "
Water	1 gal.

Anode: Zinc/Cadmium/Mercury in the ratio of 8/4/1 or 8/2/1.

Protective Coating

U. S. Pat. 2,255,780. H. L. Kohler, assignor to A. A. Kramer, Sept. 16, 1941. Increasing the corrosion resistance of a galvanized sheet having a damaged area in the zinc coating produced by fabrication operations after galvanizing, comprising the spreading of a soft, creamy, putty-like amalgam of zinc and mercury containing from 80% to 90% mercury by weight over and adjacent the damaged area of said sheet.

Pickling Silicon Steel

U. S. Pat. 2,249,383. D. C. Hilty, July 15, 1941. A process for removing the red color from heat treated silicon steel while effecting substantial scale removal including subjection to an acid solution containing sulfur dioxide with a temperature not exceeding 140° F., the sulfur dioxide being maintained at a concentration in excess of 0.025% by weight of solution, to effect the removal of the red color and the acidity being sufficiently high to effect substantial scale removal.

Example:

Sulfuric acid ..... 7% by weight
Sulfur dioxide ... over 0.025% " "
Temp. below 140° F.

The action may be accelerated by addition of small amounts of hydrochloric acid. The sulfur dioxide is maintained by gas injection or addition of sulfites or thiosulfate.

Corrosion Prevention of Iron and Steel

U. S. Pat. 2,257,668. G. Becker and F. Steinberg (Germany), Sept. 30, 1941. A method of chromizing iron and steel surfaces comprising passing a gaseous mixture consisting essentially of hydrogen and chromous chloride from a source of supply through a heated chamber containing the articles so as to cause a stream of said mixture to pass continuously over the articles, whereby said surfaces will be continuously acted upon by a mixture of hydrogen and chromous chloride for a chromizing treatment of any duration, the chamber being heated to such temperature as will maintain the articles at at least 900° C., and regulating the rate and duration of flow of said mixture for controlling the thickness of the protective layers.

Tin Deposition

U. S. Pat. 2,250,843. R. T. Robinson, July 29, 1941. A process for producing tin which comprises subjection to electrolytic action an hydrochloric acid solution of tin, such solution being between 0.006 and 0.25 Molal with respect to tin, from 0.03 to 0.54 Molal with respect to iron and having throughout the electrolytic action an oxidation condition corresponding to between one-half and all of the tin present in the stannic form whereby the iron is present substantially entirely in the ferrous form. The solution may contain a small quantity of glue, preferably 5-100 parts per million. The process is suggested for refining and detinning at room temperature with graphite anodes.

Grinding Wheel

U. S. Pat. 2,256,367. C. Wolf, Sept. 16, 1941. In a grinding wheel of molded abrasive material and having a flat rear face, reinforcing means including a plurality of nuts spaced apart about the wheel, and a ring of flat strip metal surrounding said nuts and spot-welded thereto, said nuts and ring being disposed with their ends and edge respectively flush with the rear end face of said wheel and embedded in the abrasive material of said wheel.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

New Buffing Wheel Rake

Advance Polishing Wheels, Inc., 844 W. 49th Pl., Chicago, Ill., have developed a new rake—their Type "B" for opening up the face of unsewed buffs used for color work.

Constant application of the buffing composition builds up a layer of grease or lubricant on the face of the buff making it difficult to color the work without a smear. Raking out such buffs with the Type "B" rake is claimed to give new life to the buff, which is exemplified by the better finish produced.

Buffing wheel rake

The rake filler is curved to prevent all of the teeth from coming in contact with the buff at one time, thus making the pull relatively light. Strong wooden handles are provided to which the rake filler can be quickly applied by means of screws.

Analytical Set for Acid Copper Solutions

Kocour Co., 4724 S. Christiana Ave., Chicago, Ill., have developed analytical sets for acid copper solutions used in electroplating and electrotyping.

These sets enable the rapid determination of sulfuric acid and copper sulfate. Model AC-2 is recommended for electrotyping and other iron-free solutions. With this set, a special hydrometer is used to determine the total amount of acid plus copper sulfate present. The acid is then determined by simple titration and the copper sulfate is determined by difference. When iron is present in the plating solution, Model AC-3 is recommended. With this set, the acid is determined exactly as in the AC-2 set, but the copper sulfate is also titrated. The AC-3 set can be used whether or not iron is present. Results obtained with both sets are directly in ounces per gallon and no calculations are necessary.

Analytical set for acid copper solutions

The set consists of a wall cabinet fitted with hardware to hold the necessary glassware during use and storage. The solutions are supplied in easily handled bottles, clearly labeled and so concentrated that very little solution is used in each test. Most solutions do not deteriorate but those that do, can be used and correct results obtained.

Complete directions are supplied which also include methods of correcting solutions should they be out of balance. Literature is available describing these sets and giving prices for the same.

Bright Dip for Copper Alloys

J. J. Siefen Co., 5657 Lauderdale St., Detroit, Mich., have announced the development of a product called, "Bryt-Dip", to be used with sulphuric acid for bright dipping of copper, brass and other copper alloys.

This development is of particular interest because of the shortage of nitric acid which is used with sulphuric acid for bright dipping.

"Bryt-Dip" is furnished as a powder and when used with sulphuric acid, the solution is claimed to have many advantages over the regular sulphuric acid dip. Its use in the following proportions is recommended.

Sulphuric acid	1 gal.
Water	2 "
"Bryt-Dip"	8 lb.

In the making of the "Bryt-Dip", the sulphuric acid is added to the water and the mixture allowed to cool to 120° F. The "Bryt-Dip" powder is added while stirring and the resulting solution is used at room temperature. The time of immersion varies from 20 seconds to 4 minutes, depending upon the condition of the work. The formula recommended makes a concentrated solution and if a weaker one is desired, water is merely added.

Prices for the product range from 25c a lb. in 25 lb. box to 17c a lb. in 200 lb. box.

Selenium Type Rectifiers

Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., have announced the development of a line of selenium type rectifiers for electroplating, anodizing and other uses requiring controlled direct current. These rectifiers utilize the highly efficient selenium stack for conversion of alternating current to direct current. No special means are required for cooling of rectifiers with lower current ratings, and force fan cooling is used on heavier units.

The units are stated to be compact and available in sizes from 100 to 3000 amperes at 6 volts. Higher voltage equipment is available for anodizing. Extreme flexibility of construction enabled by grouping of the selenium rectifier plates and great flexibility of the entire power source is made possible by the selection of several units. High operating efficiency is claimed for the rectifiers throughout the entire load range. Better efficiency is claimed in the lower ranges of percentage loads over that of motor generator sets.

Professional Directory

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SALT SPRAY TESTING — CERTIFIED TO MEET ARMY AND NAVY SPECIFICATIONS. Testing of deposits-thickness, composition, porosity. Solution analyses, plant design, process development.
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Metal Finishing Consultant
Plating plants streamlined for defense work.
114 E. 32nd St., N. Y. C.

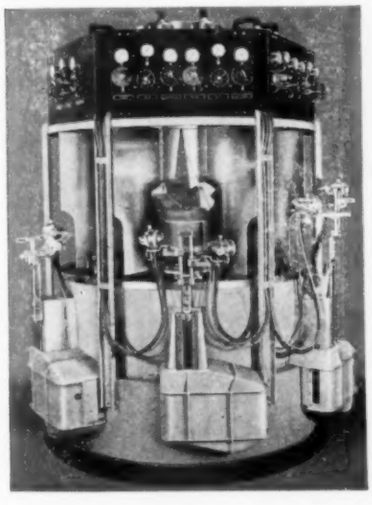
The life of the selenium rectifier is said to be practically unlimited, and experience has shown that units give trouble-free performance for years with no special care or attention.

Literature on the selenium rectifiers built by L'Hommedieu can be obtained by writing to the company.

New Automatic Metallizing Machine for Aircraft Cylinders

Developed and manufactured by U. S. Galvanizing & Plating Equipment Corporation, Brooklyn, N. Y., in collaboration with Metallizing Engineering Co., Inc., Long Island City, N. Y., this new automatic machine eliminates many former hand spraying operations on aircraft cylinders —assures accurately applied and consistently uniform coatings.

Recently installed by Pratt & Whitney, Wright Aeronautical, Buick, Studebaker, and other large engine manufacturers, for the spraying of aluminum and similar corrosion-resistant metals on air-cooled cylinders, it is capable of turning out from 30 to 40 complete cylinder assemblies per hour. It may be readily adapted to production coatings on other parts.



Automatic metallizing machine

The machine comprises six individual stations—each controlled by reducing gears and fully adjustable to various motions and speeds. Cylinders are loaded at Station No. 1 and then indexed to Stations Nos. 2, 3, 4, and 5, where metal coatings are automatically applied to different sections of the cylinder assembly. Station No. 6—the final step in the cycle—is for inspection and for unloading.

Plating Zinc on Steel From Waste Materials

In these days of metal shortages, a new process for using waste instead of new metals should interest manufacturers of wire, strip and other metal products.

The Hubbell-Weisberg Process is a new method of electroplating steel products with zinc. Its advantage lies in its ability to use cheap sources of zinc instead of zinc anodes. Zinc is dissolved from galvanizer's skimmings, brass foundry fume, organic reduction residues or ore, by a solution of ammonium chloride and ammonia. Insoluble graphite anodes are used in the plating tank. Plating reduces the zinc content of the plating solution which is then returned to the leaching plant where the zinc removed by plating is replaced.

The process produces zinc coated wire or strip which is equal to that produced by other zinc plating methods. Steel handling, pickling and cleaning are the same as for other processes. The plating tank has been specially designed to take advantage of the fact that anodes seldom have to be changed, and to provide covers which prevent the escape of ammonia fumes and at the same time permit easy re-threading of wires or strips.

The process works at high current densities and this fact combined with the high conductivity of the solution and the careful design of the electrical equipment, from generator to contactor, makes the process highly economical of electric power.

The outstanding value of the process lies in the savings due to the low cost of the zinc going into the plating operation. These savings increase as the amount of zinc used increases, because a special plant has to be provided to put the zinc in the skimmings or other products, into solution, and the operating costs of this plant must be added to the purchase price of zinc in skimmings, etc., to obtain the actual cost of the zinc used in the plating tank. The process becomes economical when about 1½ to 2½ tons of zinc are required every twenty-four hours, depending upon the cost of zinc materials available. As the daily consumption of zinc increases above this minimum, the savings become increasingly impressive.

The Hanson-Van Winkle-Munning Co., Matawan, N. J., is the sole selling agent for this process.

Speed PRODUCTION— ELIMINATE ACID LOSS

SAVE ACID and IMPROVE PICKLING

ENTHONE ACID ADDITION AGENT when added to sulphuric or muriatic acid pickles gives you these advantages:

Savings in Acid
Less Fumes
Faster Pickling
Better Heavy Chrome Stripping
Uniform Pickling
Less Attack on Base Metal
Lower Acid Drag-out
Improves Electropickling

These advantages are not just laboratory results, but are also based on experience of scores of large scale industrial users. A recent letter from New Hampshire stated: "Your Acid Addition Agent is all that you claim. I don't know how I ever got along without it." This satisfied customer is stripping heavy chromium plate from steel. Better, more uniform pickling means better plating. In addition to this Enthone Acid Addition Agent helps you to save acid which is important because of the shortage of acids.

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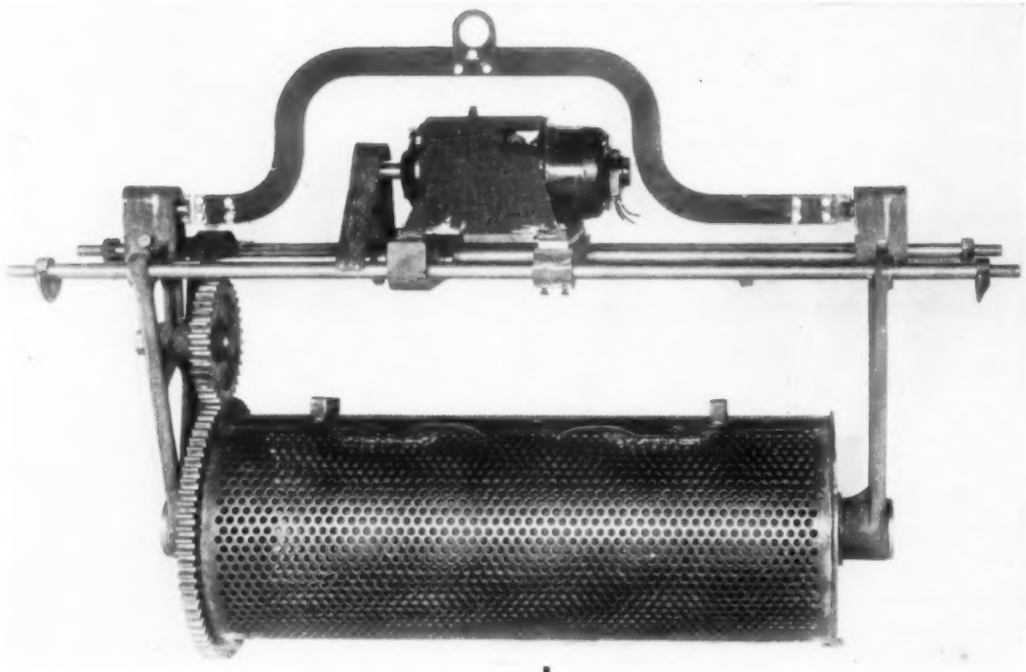

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Save Time and Labor Conserve Solutions, and Speed Up Production

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- *A variety of sizes to suit your needs.*
- *Rugged construction for long, hard service.*

Reduce your production worries with Lasalco Motorized Tumbling Barrels. Because the barrel continues to revolve as it is being lifted from the solution, there is less dragout loss. The solution drains back into the tank without laborious, time consuming, hand shifting of the cylinder.

In addition, Lasalco Motorized Tumbling Barrels are portable—allow MORE VERSATILE, MORE FLEXIBLE operation. They can be moved from one tank to another quickly and easily with very little set-up time required. These tumbling barrels can do double or even triple duty if your operations require a machine that can handle varying processes to meet varying grades or types of materials.

Lasalco Motorized Tumbling Barrels are being used to process many parts through cleaners, rinses, pickles, and rust proofing solutions.

Lasalco, Inc., offers a complete line of metal finishing and plating equipment. Let a Lasalco engineer help you solve your metal finishing problems. Write or wire for complete information and prices.

LASALCO, INC.

2820-38 La Salle Street — St. Louis, Missouri

Rectifier Voltage Regulator

The Benwood Linze Co., 1819 Locust St., St. Louis, Mo., have developed a voltage regulator, to be used in conjunction with their line of standard metallic rectifier electroplating units.

The B-L voltage regulator, manually operated, is especially designed to provide a convenient and simple means for adjusting the voltage output of each individual or bank of rectifiers.

The regulator is available in a wall mounting cabinet so it may be installed adjacent to the plating tank within convenient reach of the operator and away from the rectifier units.

The voltage regulator has 64 steps of adjustment, giving a voltage range from maximum down to one volt. The coarse control covers the full range in eight steps while the fine control provides eight steps for each step of the coarse control.

In addition, the regulator provides a start-stop station permitting remote control for starting and stopping the rectifier, thereby giving the operator complete control of each tank.

Incorporated in the front of the unit are two accurate, easily read meters, sealed to protect against moisture and dust. One voltmeter and one ammeter record current and voltage of each individual rectifier.

By this method of control, all the convenience of an individual tank rheostat is obtained, but the rheostat losses of bus bar control are eliminated.

The elimination of no-load losses is possible due to the fact that the operator can shut down the rectifier whenever a tank is not in use.

Descriptive literature and prices may be obtained from the manufacturer.

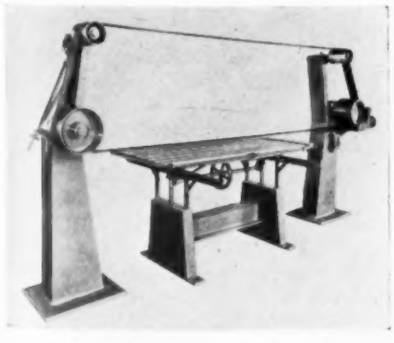
Endless Belt Sander

Illustrated is an endless belt sander manufactured by Jefferson Machine Tool Co., for sanding and finishing large, flat, as well as concave or convex surfaces on wood or metal. The large table travels on ball bearing rollers and is easily moved back and forth while the operator applies pressure to the flexible belt with a block or pad.

The height is adjusted to enable the operator to perform his work with a minimum amount of fatigue. Overhead idlers keep the upper travel of the belt out of the operator's way. The sanding belts can be easily and quickly changed. The table has a vertical adjustment of 10" which provides for large work thickness, and the belt standards may be set as far apart as desired to accommodate long surfaces.

An auxiliary work table can be placed on the regular table for handling exceptionally long materials and the table stand may be readily moved to one side for special work.

Specifications on Jefferson endless belt sanders are given in a bulletin available from the Jefferson Machine Tool Co., Fourth, Cutter & Sweeney Sts., Cincinnati, Ohio.



Endless belt sander

Emulsion Cleaner

Quaker Chemical Products Corp., Conshohocken, Pa., have recommended their "Quasol No. 80" for use in emulsion cleaning of metal.

The material is a red colored clear liquid which is stated to mix with hot or cold water to form a stable emulsion with good wetting and cleaning properties. It is mixed with water in proportion of 1 gallon to from 25 to 75 gallons of water depending upon the difficulty of the cleaning job. Operating temperature recommended is between 130° and 160° F.

The washing machine is operated in the usual manner. It is claimed that heavy coatings of mineral oil are removed more rapidly with the emulsion cleaner than with ordinary alkalies, and that no alkali, rust or white streaks form on the work, and that a light film remains on the work to act as a rust preventive.

In addition, it is stated that the solvent can be used on all types of metals without danger of injury to the metal or worker, and also without danger of fire or explosion. The oil which is removed from the work, collects on the surface of the cleaning mixture in the washing machine and can be skimmed off.

Cleaning costs are stated to be low and

Consider Just

TWO OF THE REASONS

Why "Miccro Products" Are TODAY Ideally Suited For Use In Your Plants

ONE: "Miccro Products"—including Miccro Supreme Stop-Off Lacquers, Miccrolite and the new Miccroflex—always provide effective resistance to elements destructive to metal surfaces or to ordinary coating materials. They stand up through complete cycles of plating operations . . . in all acids and cleaning solutions. Because of this protection, there is no possibility of surfaces becoming exposed, and valuable plating metals being wasted as they pile up at uncovered spots.

TWO: These protective coatings are manufactured for *your* use. They eliminate your need of relying on outside sources of supply—the installation of simple, inexpensive dipping equipment providing you with all necessary facilities. When you require protective coatings—for your plating racks or for other purposes—"Miccro Products" provide you immediately with the means to completely control their application in your own plant. And you will find that they are applied quickly, easily and at extremely low cost.

These are only two of the many reasons why you will find it to your advantage to use these coatings which have been developed and are manufactured by experienced platers for the use of the entire plating industry. There are at least a dozen more features which are important to you —and particularly at the present time. They are covered completely in our literature—yours for the asking. WRITE TODAY.

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MICCROLITE

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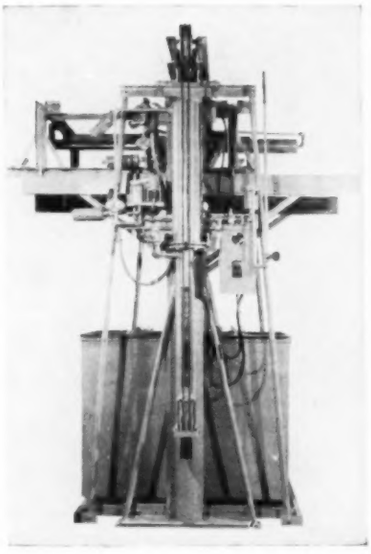
MICCROFLEX

Developed and Manufactured by Experienced Platers

MICHIGAN CHROME & CHEMICAL CO.

6348 EAST JEFFERSON • DETROIT, MICHIGAN

Crown Pick-up Unit



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A UNIT TYPE TRANSFER CAPABLE OF HANDLING SEVERAL TANKS AT ONE TIME.

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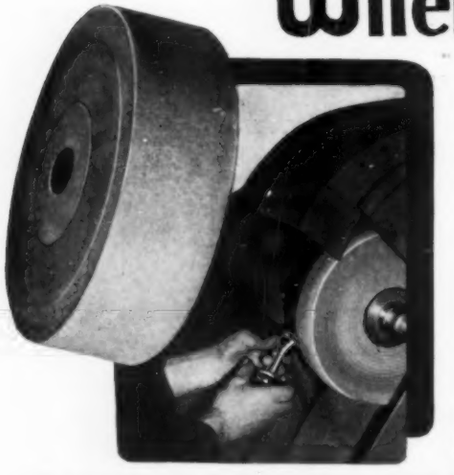
...USE...

FOR A SERIES OF OPERATIONS WHERE THE WORK MUST PASS THROUGH SEVERAL TANKS, AS THE CLEANING AND RINSING OPERATIONS, FOR A SEMI-AUTOMATIC PLATING TANK.

CROWN RHEOSTAT & SUPPLY CO.
1910 MAYPOLE AVENUE :-: :-: CHICAGO, ILLINOIS

When BEST it's FELT



Companies that make their product look worth the difference to the buyer use *Paramount Brand* Felt Polishing Wheels to polish the base metal, knowing that to have the best finish, you must start right, which means, *Paramount* Felt Polishing Wheels.

Ask Your Supplies Salesman for PARAMOUNT BRAND

BACON FELT CO. WINCHESTER MASS. ESTABLISHED 1824

control is simply accomplished. Technical data on "Quasol No. 80" and a method of control are given in a bulletin available from the Quaker Chemical Products Corporation.

Repair Compound for Tin Coatings

A new metal coating compound, marketed under the name of "Amco Metallic Coating Powder, Brand 'K'" has been developed by the American Solder & Flux Co., Trenton Ave. & Norris St., Philadelphia, Pa.

The new product is designed for making repairs to damaged tin coatings. While the finished coating has the appearance of tin and matches perfectly with the surrounding hot dipped tin coating, it has an advantage not possessed by the original tin. Amco Brand "K" coatings are claimed to be completely rust resistant and to protect the underlying iron or steel to the same extent as hot dipped zinc coatings of the same thickness. This unusual and important property is due to the fact that when in contact with iron or steel in a corrosive medium, the coating is electropositive and therefore affords protection against rust and corrosion.

The material is intended for use wherever an original tin coating has been damaged in handling, worn away through use or burned away in a welding operation. Since the melting point of the coating is lower than that of tin, the original coating is not melted or disturbed in any way by the application. The coating on the repaired areas joins with the undamaged surrounding areas of tin, forming a continuous and protective surface.

Since the finished job looks the same as the tin, the repair coating may be used wherever appearance is a factor. It is quite satisfactory for use on those surfaces of food containers which do not come into direct contact with the food itself.

Synthetic Detergent

A synthetic detergent called Triton 720 and described as "an aqueous paste of a sulfonated ether salt" is announced by Rohm & Haas Company, Philadelphia, Pennsylvania.

It is said to be widely useful in the enameling and electroplating fields where its stability makes it suitable for either acid pickling baths or alkaline cleaning solutions.

In a new book released by the manufacturers, Triton 720 is said to disperse scum that forms on the top of acid pickling tanks, thus increasing the life of the acid and eliminating faulty cleaning. When Triton 720 is added to the acid bath, a light foam forms on top of the tank and prevents disagreeable acid fumes from escaping. In alkaline cleaning solutions, concentrations of Triton 720 ranging from 1/10 to 2% on the weight of the bath are recommended, and are said to remove greasy film from metal and prevent precipitation of metal salts on the surface of the parts.

Manufacturers' Literature

Abrasive Blasting

American Foundry Equipment Co., 621 S. Byrkit St., Mishawaka, Ind., have recently issued a 16-page pamphlet entitled, "The Airless Wheelabrator", which describes the company's mechanical unit that utilizes controlled centrifugal force instead of compressed air for abrasive blasting. Sectional drawings and descriptive matter explain the constructional features of the abrasive blasting machine. Advantages of this type of cleaning, applications, and cost studies are given. Various models of equipment are described and illustrated.

Analytical Sets for Acid Copper Solutions

Kocour Co., 4724 S. Christiana Ave., Chicago, Ill., have recently published literature describing their new analytical sets for determining sulfuric acid and copper sulfate in acid copper electroplating and electrotyping solutions. The sets enable rapid determination of the components of the copper solutions, with results being determined directly in ounces per gallon. Two sets are available—one for iron-free solutions, and the other for solutions containing iron.

Blackening Process for Steel

E. F. Houghton & Co., Third, American & Somerset Sts., Philadelphia, Pa., have issued a four-page folder describing their process "Houghto-Black", which is a chemical process for applying a jet black oxide to the surface of steel. The solution is made by dissolving the salts with a specified amount of water, and the operating temperature is 290° F. Advantages of the process, various applications and specific operating details are given in the folder.

Cleaning Machinery for Metal Parts

N. Ransohoff, Inc., Township Ave. and Big Four R.R., Cincinnati, Ohio, have just issued a 28-page catalog describing and illustrating various equipment made by the company for washing, rinsing, drying, burnishing and pickling of metal parts.

The photographs are particularly good, being large and clear, and many show equipment in actual use. Various constructional details of the equipment are given as well as views in the Ransohoff plant. A partial list of users of the Ransohoff equipment is appended.

Combustion Control Instruments

Permutit Company, 330 W. 42nd St., New York, N. Y., have just published Bulletin R 40 entitled "Ranarex Instruments", which discusses and illustrates the company's equipment for controlling combustion of gaseous fuels, coal and oil. Technical data on proper combustion are given and principles of combustion are discussed.

Endless Belt Sander

Jefferson Machine Tool Co., Fourth, Cutter and Sweeney Sts., Cincinnati, Ohio, describe their endless belt sanders for wood work and for metal work in a recently issued circular. A large photograph shows the sander ready for use and specifications and operation features are given in the text.

Foundry Ovens

"Gehnrich Foundry Ovens" is the title of Catalog No. 198 of the *Gehnrich Corp.*, 42-03 35th St., Long Island City, N. Y., which describes various type ovens made by the company, for core baking, mold drying and heat treating. Sectional drawings and photographs are profusely used to illustrate the ovens. The ovens described include external air heated ovens, direct heated ovens and ovens with circulation system. Various protective features and constructional details are discussed. The ovens may be fired by oil, gas, coke or electricity. This catalog will be sent to any interested readers by writing to the Gehnrich Corp.

Polishing and Buffing Wheels

Advance Polishing Wheels, Inc., Chicago, Ill., have just published a 27-page catalog describing and illustrating various wheels for buffing, polishing and coloring of metals and other objects. Included in the cata-

STILL GOOD *after handling* **10,000 TONS** *of Nuts and Bolts...*

Record made by this type of basket proves Monel-equipped Pickling Room is no bottle neck

One sure way to speed pickling room production is by using Monel equipment. Proof? Consider the experience of United Platers, Inc. of Detroit:

Because inferior equipment caused loss of production, United changed to Monel for pickling baskets. Result: Eight Monel baskets like those pictured have handled 10,000 tons of nuts, bolts, washers, and are still in good condition.

Today, in the pickling room, you want no breakdowns but *faster production*. Strong, lightweight equipment of Monel is the answer. Write for full information on how to get it. Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N.Y.

MONEL

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

Monel dipping baskets made by Naum Saba, 2266 E. Congress, Detroit, for United Platers, Inc., 944 Madison St., Detroit. Eight similar baskets still good after handling 10,000 tons of nuts, bolts and washers.

log are descriptions, illustrations and specifications for bobs, buffs, bushings, discs, flanges, glue, leather, polishing wheels, rakes, shapes and spacers. Special attention is given to the patented "Perm-A-Core" feature. Schematic drawings illustrate the assembly of buffs with "Perm-A-Core", enabling the obtaining of hard buffs, soft buffs and special arrangement of buffs for all types of work. Copies of this catalog can be obtained by writing to Advance Polishing Wheels, Inc., 844 W. 49th Pl., Chicago, Ill.

Safety Equipment

American Optical Co., Southbridge, Mass., have just issued a new 111 page safety equipment catalog. Equipment is described for complete protection of the operator, from head to ankles, including goggles, welding lenses, welding plates, safety clothing, respirators, first-aid kits, etc.

Selenium Rectifiers

Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., have recently issued literature describing their new selenium type rectifiers, which are available in sizes from 100 to 3000 amperes at 6 volts and at higher voltages for anodizing. Constructional details and advantages of the rectifiers are given in the literature.

Thermometer and Pressure Gauge Accessories

The Brown Instrument Company, a division of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., have recently issued their catalog No. 6706-A which devotes 24 pages to a discussion of the company's pressure gauge thermometers, hygrometers and various accessories. The catalog is illustrated with actual photographs of the various accessories used with the company's thermometers and gauges. Specifications are also given.

Temperature Controls

The Foxboro Co., Foxboro, Mass., have recently issued an illustrated folder describing automatic temperature controls for electroplating processes. Specifications for these controls are given and long distance dial type temperature indicators are also illustrated. Four typical installations of the company's equipment in plating plants are shown.

Technical Publications

"Chromium Chemicals—Their Uses and Technical Properties." Mutual Chemical Co. of America, 270 Madison Ave., New York. A limited number of these publications is available.

This valuable booklet on the compounds of chromium discusses sodium bichromate, sodium chromate, potassium bichromate, potassium chromate, ammonium bichromate and chromic acid. This discussion includes description and principal uses, grades and packing. Physical data on chromium salts are given, such as Baume tables, solubility curves, pH curves and freezing point curves. Equilibrium composition — temperature curves for various salts with water are included.

Symposium on Color

This symposium sponsored jointly by two organizations—the Inter-Society Color Council and the American Society for Testing Materials, stresses the importance of adequate specifications for color and discusses the use of color in the testing and evaluation of materials. Following the Introduction to Color by Deane B. Judd, who covers the attributes of colors, and the distinction between the psychological definition of color and the technical definition, there is a paper on "Color Specifications of Transparent Materials" by Francis Scofield who reviews critically the various sets of standards. R. H. Sawyer, whose paper covers "Hiding Power and Opacity" discusses the most significant theoretical and empirical relations which have been developed and those practical testing methods which have attained widest recognition. "Color Standards for Opaque Materials" is the subject of I. H. Godlove's paper, who points out that material standards may vary from haphazard and variable traditional objects which lead to unprecise color names, to groups of standards such as the Ostwald and Munsell systems. The two closing papers deal with the practical problems of color testing, one by A. E. Parker, entitled "Spectrophotometry and Color Evaluation" and the other by R. S. Hunter covering "Photoelectric Tristimulus Colorimetry."

Copies of this 86-page publication can be obtained from the A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at $1.00, heavy paper cover; cloth binding, $1.25.

SPEED UP
YOUR DEFENSE OUTPUT
WITH
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Fatigue of Metals. By D. Landau, Industrial Applications Engineer. The Nitralloy Corp., 230 Park Ave., New York, N. Y.

This book is an introduction to the subject of fatigue of metals and is intended chiefly for the design engineer, to the study of conditions which limit the stress in metals by fatigue. Free of charge.

Bibliography of Blast Cleaning with Metallic Abrasives. Compiled by Ralph Hopp, Technology Department, Carnegie Library of Pittsburgh. Reprinted from Heat Treating and Forging, June-July 1941.

Twenty-five pages are devoted to literature on blast cleaning and abrasives used for this purpose. The booklet is arranged alphabetically according to authors' names.

Tentative Specifications for Electrodeposited Coatings of Zinc, Cadmium, Nickel and Chromium. Issued 1941, by the American Electroplaters' Society and American Society for Testing Materials. It can be secured either from W. J. R. Kennedy, secretary of American Electroplaters' Society, 93 Oak Grove Ave., Springfield, Mass., or C. L. Warwick, secretary-treasurer, American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.

Specifications and methods for testing of zinc coatings on steel, cadmium on steel, nickel and chromium on steel, nickel and chromium on copper and copper base alloys, and nickel and chromium on zinc and zinc base alloys are given.

Tentative methods are outlined for determining the local thickness of electrodeposited coatings.

"*Standard Protects Workers in Electroplating Operations*" is the title of an article that appeared on pages 229-230 of the September 1941 issue of *Industrial Standardization*, the publication of the American Standards Association. The article was written by Cyril Ainsworth, Secretary of the ASA Committee on the Safety Code for Exhaust Systems.

The purpose of the article is to help protect the many additional workmen employed by defense industries who will be exposed to the potential health hazards in electroplating.

A copy of this article can be secured by sending 30c to the American Standards Association, 29 W. 39th St., New York.

"*ASA Approves Safety Standard for Grinding, Buffing and Polishing,*" is the title of an article appearing on pages 231-3 of the September 1941 issue of *Industrial Standardization*, a monthly publication of the American Standards Association.

Standards for grinding, buffing and polishing equipment sanitation—Z43-1941 originated in the American Foundrymen's Association. After general approval by members of the foundry industry, regulatory bodies of several states, and other interested groups, it has been approved by the American Standards Association as an American standard. Copies are available through the above association, 29 W. 39th St., New York, at 60¢.

New Books

Vocational and Professional Monographs: Metallurgy. By Robert S. Williams, Ph.D., Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. Published by Bellman Publishing Co., Inc., 6 Park St., Boston, Mass. Twelve pages. Price 50 cents.

This monograph was written by a well known metallurgist and has been designed to enlighten one who is considering the study of metallurgy or who wishes to know the general scope of metallurgy and sources of information regarding the same.

The contents include a discussion of the history of metallurgy, then the definitions and divisions of the field and thirdly, the various duties of a metallurgist in industry. Qualifications and prerequisites for the professional study of this subject are discussed.

Sources for obtaining education and training are listed according to states. Various curricula, employment problems and compensation are considered. The various associations, societies and journals in the field are briefly discussed.

Glossary of Metallographic Terms. Compiled by J. Neill Greenwood. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y. Size 5¾" x 8¾"; 80 pages. Price $2.00.

The author has not just defined the various metallurgical terms but has given each term considerable treatment. Equilibrium diagrams, annealing curves, for example, are used to illustrate the respective features of the text.

At the end of each section, cross references are given to other sections which have a bearing on the particular subject. Some typical technical definitions discussed are: age hardening, annealing, blue brittleness, ductility, slip lines and yield point.

Joe New Buff: "When they put you in that pile of half worn down buffing wheels, I thought you were all through. It's good to see you back on the job."

Joe Old Buff: "Thanks! But give credit to the boss for buying that HAMMOND "VRO" Variable Speed Polishing Lathe. Now I'm good way down to the flanges."

Just the turn of a handy dial gives you instant speed changes from 1500-3000 RPM. And constant peripheral speed gives you better, more uniform finish and highest production.

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Eastern Branch—71 West 23rd Street, New York City

This glossary should be useful to engineers, metal craftsmen, mechanical dentists, students and all those concerned with the constitution and internal structure of metals and alloys.

New Encyclopedia of Machine Shop Practice. Edited by George W. Barnwell. Published by Wm. H. Wise & Co., Inc., New York. Size 5¾" x 8¾"; 548 pages. Price $1.98.

The book is clearly written in non-technical language and is more a compendium of general modern information in its field than a mere reference encyclopedia.

Included in the contents are detailed explanations of the operation of such standard machine tools as the lathe, milling machine and centerless grinder. Gear cutting, heat treatments, forge and foundry work are also covered in easy, informative style. In one chapter it gives a complete home study course on the use of hand tools. It then covers the whole area of metal working by modern machinery, and ends with a fifteen-page index.

Drawings to illustrate the text are profusely used.

Chemical Engineering Catalog. 1941-1942. Twenty-sixth annual edition. Published by Reinhold Publishing Corp., New York. Size 8¼" x 11¼"; 1214 pages. Distributed, free, to individuals in the chemical industry, provided the catalog is returned to Reinhold Publishing Corp., when the new edition comes out each year. Price for permanent possession is $3.00.

This authoritative guide in the chemical engineering field contains an alphabetical trade name index. It has a catalog of chemical equipment and supplies, and a special technical data section giving information on such subjects as humidity, V-belts, size distribution and surface area and flow of gases is included.

The book contains a cross index of suppliers and manufacturers of chemicals and chemical materials. There is also a special index on technical and scientific books and these various books are described in the concluding section of the catalog.

Emulsions and Foams. By Berkman and Egloff. Published by Reinhold Publishing Corp., New York. 1941. Size 6" x 9"; 591 pages. Price $8.50.

Here is a subject that will attract the attention of many in a variety of industries, for the difficulties or advantages of emulsions and foams have long been recognized. Necessarily based on many hundred literature and patent references, all of which are noted, the book is designed to provide a theoretical and practical background useful in attacking problems on emulsions and foams.

That there is much to be learned about the subject is early pointed out, for it is stated that a great many investigators have studied the nature of emulsions, their properties, formation, destruction and stability, but usually only a single system has been studied at a time and that with one or two significant factors or characteristics. No one system has been investigated in its many phases. It is with this that the book begins—a review of these factors and characteristics after which, in summary, a manner in which future investigations should be carried out viz.—(1) a logical and separate grouping of factors influencing emulsification, permanence of system formed, and its transition from one type to another, (2) more accurate methods of investigation, (3) only emulsion systems similar in nature and type should be compared with respect to their various properties, and then only under comparable conditions.

With regard to foams, the origin and mechanism of foam formation, the stability of foam systems and the transition to the unstable state are treated as the three differentiated stages. Up to this point the theoretical aspects of the subjects are treated.

Practical knowledge of emulsions constitutes the greater portion of the book. This begins with methods of preparing emulsions, the emulsification process and types of equipment used for emulsification. Demulsification is next taken up—the methods used, such as heat treatment, action of chemicals and agents, freezing and diluting, etc. Attention is given asphalt and bitumen emulsions with regard to road construction and lubrication oil emulsions.

The last part of the book is devoted to

CLEANING SPEED

Wyandotte M.K. 50, the new solvent for use in power washers, is showing spectacular cleaning results on many defense manufacturing jobs.

The need of the times is for speedy and economical cleaning, and Wyandotte M.K. 50 (plus water) in power washers fills the bill to a T.

Wyandotte M.K. 50 cleans all metals and will not attack any metal —aluminum, magnesium, copper, brass, zinc or cadmium.

It is successfully cleaning airplane motor parts during processing prior to assembling . . . cleaning aluminum castings prior to anodizing . . . cleaning steel stampings and castings after machining and prior to painting and lacquering . . . cleaning brass and aluminum screw machine products . . . cleaning stainless steel after stamping and drawing.

Why not call in your Wyandotte Representative and have him check over your cleaning operations? The chances are he can save you time and money. He may show you a short cut or a new cleaner.

Wyandotte PRODUCTS

SERVICE REPRESENTATIVES IN 88 CITIES

THE J. B. FORD SALES COMPANY, WYANDOTTE, MICH.

a description of laboratory methods used in the examination of emulsions.

The book is the result of an exhaustive search of the literature on the subject coupled with a broad knowledge and the ability of good presentation. A comprehensive subject and author index adds much to the value of the book for reference purposes.

Associations and Societies

Los Angeles

A motion picture entitled "Coated Abrasives" was presented under the sponsorship of the Behr-Manning Corp. of Troy, N. Y., as the feature of the educational program of Los Angeles Branch's monthly meeting at Hotel Rosslyn on October 8.

The picture showed the application of electricity for setting up abrasive grains in papers by the use of electro-static forces. Following the projection of the film, *C. S. Hastings* of the Troy office of the Behr-Manning Corp., and *P. S. Wiswell*, Southern California manager, answered questions from the floor. This period brought forth some interesting discussion due largely to the fact that the use of coated abrasives is limited to Southern California, where abrasive wheels are chiefly used.

The educational program was concluded with the showing of an entertainment film, "Grand Canyon Economy Run," through the courtesy of the Gilmore Oil Co.

The business session was presided over by President *Don Bedwell*. The chair welcomed back First Vice-president *Frank C. Rushton* who was attending his first branch meeting following his return from a visit of some six weeks in the middle-west.

The business session was highlighted by the appointment of a special Program Committee. This action was taken in response to suggestions from various members that the monthly educational programs in the future be confined to a maximum of 30 minutes duration.

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Cyanide Copper
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Cadmium
High Speed Copper
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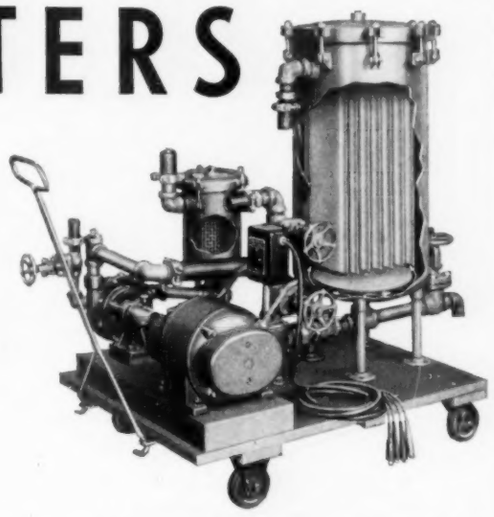
And Others



INDUSTRIAL FILTERS will do a fine job of filtering and purifying your plating solutions, at the lowest possible cost per filtered gallon.

INDUSTRIAL FILTERS have larger filter areas, more sludge holding capacity and higher pressure pumps, which insures high flow rates and longer filter cycles.

The "LEAK-PROOF", "CORROSION-PROOF" and non-contaminating construction of Industrial Filters is a vital requisite of Electroplating filters.

SALT SPRAY
CORROSION TEST EQUIPMENT

For testing—Electroplated or coated metals at 95 deg. Fah. in accordance with Army, Navy and Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1938. Also for controlled temperatures at any degree. Testing Cabinets lined throughout with rubber. Made in 4 sizes.

"Write for NEW Literature and particulars."

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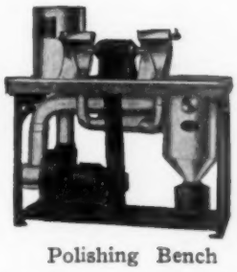
Polishing Bench

Dryer

Tubbing

Sawdust Box

Sandblast

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★ DRAWING COMPOUNDS
★ POLISHING AND BUFFING COMPOSITIONS

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• FORMAX MFG. CO., 3999 18th St., DETROIT, MICH. •

Obituary

August P. Munning

August P. Munning passed away on Oct. 29 at the home of his daughter, in Matawan, N. J., after several months illness. He was 68 years old.

A. P. Munning was one of the outstanding figures of the electroplating industry of America. Born in Chicago, March 8, 1873, he entered the electrical industry at an early age, going with the Leonard Izard Co. who were then agents for the original Edison Co., in 1888. At a later date he joined the Cutler Hammer Mfg. Co. of Milwaukee, rising with them to the post of General Sales Manager, with offices in New York.

In 1911 Mr. Munning entered the electroplating equipment and supply business, organizing the Munning Loeb Co. in Matawan, N. J. In 1918 this firm was merged with the George Zucker Co. of Newark, with Mr. Munning as president of the new concern, A. P. Munning and Co. In 1927 the latter company was merged with the Hanson and Van Winkle Company to form the Hanson-Van Winkle-Munning Co., with Mr. Munning as Chairman of the Board. He retained this post until his retirement in 1935. A few years later Mr. Munning again became active in the Hanson-Van Winkle-Munning Co. as a member of the Executive Committee. He again retired in 1940 to become President of the Matawan Bank, in which post he continued until his recent illness.

August P. Munning

Mr. Munning was internationally known for his accomplishments in the electroplating industry. He was an Edison Pioneer. He was a strong supporter of the American Electroplaters' Society and an ardent believer in raising the standards of the industry.

Mr. Munning leaves his mother, Mrs. August A. Munning of Chicago; his widow, Mrs. Anna V. S. Munning; a daughter, Mrs. John A. Bauer; four brothers, Nicholas and Peter Munning of Matawan and Joseph and Harry Munning of Chicago; and a sister, Mrs. Charles Thelen of Chicago.

Personals

H. Tom Collord Founds Protective Coatings, Inc.

H. Tom Collord, founder of *Collord, Inc.*, has announced the formation of a new corporation called *Protective Coatings, Inc.*, with address at 10391 Northlawn, Detroit, Mich. The company features a complete line of products for the protection and preservation of materials used in manufacturing. Their service includes complete rubber installation as well as many products for protection of plating structures, metals and other types of materials against outdoor exposure, acids and other corrosive media.

Mr. Collord has worked for the past few years in cooperation with a group of industrial laboratories in the development of unique coatings which his new company now sells. He is also known as founder and president of *Paramount Rubber Service, Inc.*, which company specializes in seamless rubber tank linings.

H. Tom Collord

Wallace W. Lockwood has been appointed Advertising Manager of the *Taylor Instrument Companies*, Rochester, N. Y., to replace *Elmer E. Way*, who has resigned.

A graduate of Auburn High School and Syracuse University, Mr. Lockwood joined the Taylor Advertising Department in 1932 and was made Assistant Advertising Manager in 1939. Previously connected with the Lapp Insulator Company, Leroy, N. Y., the Z. L. Potter Advertising Agency and the David Tynion Advertising Agency, both of Syracuse.

The Porcelain Enamel and Manufacturing Company of Baltimore, Maryland, announces the appointment of *George L. Hubbell* as Sales Engineer for the midwestern territory. Mr. Hubbell has had wide experience having formerly been District Sales Manager for the Globe Wernicke Company, Production Manager and Southeastern Sales Manager for the E. F. Hauserman Company, manufacturers of steel products, and recently having been connected with the Home Owners' Loan Corporation of Washington, D. C.

Charles J. Slunder has been named to the research staff of *Battelle Memorial Institute*, Columbus, Ohio. He has been assigned to the Institute's division of electrochemical research.

A graduate of Massachusetts Institute of Technology in electrochemical engineering, Mr. Slunder has had fifteen years of experience in the field of industrial electrochemistry. Prior to joining the Battelle staff he was with the Aluminum Company of America and earlier held positions with the United States Rubber Company, Packard Motor Company, and Dodge Bros., division of Chrysler Corporation. He is a member of the Electrochemical Society.

Business Items

Douglas Aircraft's New Plating Plant

By Fred Herr

Coincident with the opening of the new finishing and plating department in the *Douglas Aircraft Co.'s* new $11,000,000 airplane plant in Long Beach, Calif., *E. R. Williams*, who has served as superintendent of the plating and polishing department at the main Douglas factory at Santa Monica, Calif., for the past 11 years, was promoted to co-ordinating supervisor of the firm's plating and polishing activities at Santa Monica, Long Beach and Inglewood.

Mr. Williams has transferred his head-

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✓ INCREASES PRODUCTION
✓ INSURES BETTER FINISH
✓ at Lower Cost

Polishing costs take a licking all along the line when this Acme 3-Wheel Automatic bites into a tough job of tube or pipe finishing. It gives a three-way savings by performing three operations in one pass through the machine. Adjustable feed speeds from 0 to 20 or more feet per minute and compensating adjustments for tube size and wheel wear meet every production and finish requirement.

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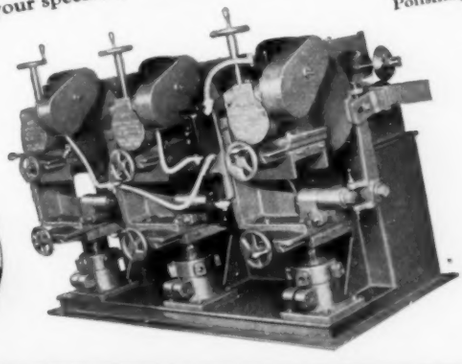
Type T-3
3-Wheel Automatic
Polishing Machine



SPECIAL MACHINERY amc AUTOMATIC BUFFING MACHINES

ACME Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

quarters from Santa Monica to the Long Beach plant. *Clarence Savage*, who has been associated with Mr. Williams at the Santa Monica plant for the past seven years, has been named superintendent of the Santa Monica plating, polishing and buffing division.

The plating and polishing division at the Long Beach plant is expected to have a personnel of 70 to 80 before fall. The plating and polishing room measures 53 by 106 feet. It is regarded as one of the most completely equipped metal finishing departments in California. The shop has a plating, polishing and sandblasting department, as well as a department equipped for the special requirements of oiling tubular assemblies with hot linseed oil.

The plating and polishing division at Long Beach is the first completely windowless plating shop in the United States. Conforming to the central "blackout" plan of the entire plane factory, the building in which the plating and polishing room is located has no windows nor skylights. It is illuminated with mercury arc lights. The shop is also probably the most completely ventilated and air conditioned plating plant in the country. With no windows to provide air circulation, the Douglas factory had to be equipped with a complete air-condition system. This has been taken care of with an elaborate refrigerated air conditioning system, designed to conform with the decentralized layout of the plant. The building in which the plating and polishing division is located is air conditioned by a series of 15 individual air conditioning plants, each serving a separate zone in the building. To conserve floor space in the working area, the air conditioning units are installed on platforms built into the roof trusses of the building, with fans installed in air ducts discharging directly downward. One such unit serves the plating and polishing room.

Heating of the plating division is also accomplished as part of a decentralized heating system. Twenty-three boiler rooms with 23 boilers constitute the plant's decentralized heating system. Heating coils installed in the ducts, aided by booster coils, on the platforms, heat the rooms by discharging warm air downward.

Theory of the decentralized installing system is protection against possible bombing attacks from the air. A bomb striking one building, it is thought, will not materially affect the other buildings, which are separated from one another by a minimum of 70 feet.

Equipment in the metal finishing shop at Long Beach includes a 2500-gallon and two 100-gallon solution tanks and a barrel tank, plus the necessary degreasers, acid pickling units and auxiliary equipment to supplement a tank-setup of that capacity.

L. J. White Co. Changes Name to Kelite Products, Inc.

It was announced recently by *W. G. Nuelsen*, President, that the name of *L. J. White Co.* has been officially changed to *Kelite Products, Inc.* No change in management or personnel is involved, and operations continue from the present address, 315 W. Hubbard Street, Chicago.

Mr. Nuelsen stated that the change was made in order to more closely identify the scope and function of the organization which operates on a nation-wide scale. Kelite Products, Inc. specializes in the manufacture and distribution of industrial cleaning compounds. He also emphasized the importance of modern cleaning methods and materials in the present emergency and their outstanding contribution to the defense program from the standpoint of speeding up operations and fostering precision.

Thompson Products, Inc., Cleveland, O., is constructing an addition of 35,000 square feet floor area to its branch factory at 8354 Wilcox Ave., Bell, Calif., at a cost of $500,000 for building and equipment. Aircraft fuselage parts will be manufactured in the new building.

Anderson Die Casting Corp., 100 East 60th St., Los Angeles, is adding 10,000 sq. ft. of floor space to its factory building. In addition to the regular output of oil purifiers, builders' small hardware and miscellaneous die castings, the firm produces aluminum castings.

Consolidated Engineering Corp., Pasadena, Calif., headed by *Herbert Hoover, Jr.*, has contracted with *Sperry Gyroscope Co.* to take over the Sperry Co.'s commitments for producing vibration and strain measuring instruments.

Papers of incorporation have been issued for the following new firms in Los Angeles engaged in metal treating and processing:

Victory Tool Co., 1862 Glendale Blvd., by George L. Brown and Frank S. Lombardi.

Aluminum Bronze Tool Co., 354 S. Spring St., by L. S. L. Rich and Irving Grossman.

United Tungsten Co., 5225 Wilshire Blvd., by A. B. Pendell, C. H. Barney and George J. Alcorn.

ABCO Metalcraft, 1008 N. Highland Ave., by Joseph F. Hypes, Jr.

Sale of the *Menardi Metals Co.* plant in El Segundo, Calif., to the *Harshaw Chemical Co.*, Cleveland, Ohio, manufacturers of anodes and chemicals, was concluded on July 28. The establishment hereafter will be known as the Menardi Metals Division of Harshaw Chemical Co. *Harold B. Menardi*, head of Menardi Metals Co., will remain as manager.

Harshaw Chemical Co. is a manufacturer of antimony oxide and various antimonial products. Under the new setup, the El Segundo plant will continue to buy Mexican Livingstonite and domestic antimony. By utilizing an electrolytic process recently installed, the California plant will be able to handle gold and silver ores containing antimony.

Menardi Metals Co. was established as an ore reduction plant in Vernon, Calif., several years ago. In the beginning it chiefly imported Livingstonite concentrates from Southern Mexico. Early this year the plant was moved to El Segundo where expanded facilities were available.

A new building of 18,000 square feet floor area has been completed at Puente, Calif., by the *Major Aircraft Foundry* for production of aluminum castings. The company will hereafter manufacture its own patterns and cores and do heat treating of aluminum castings.

Small Motors, Inc., Chicago, Ill., have moved to new and enlarged offices and factories at 1308-22 Elston Ave., Chicago, thereby combining all of their facilities under one roof. They were formerly located at 1733 Milwaukee Ave.

Crowncraft, Inc., 3509 East Olympic Blvd., Los Angeles, has gone into production of assembly jigs and fixtures to serve the major aircraft companies and has installed the necessary plating and polishing equipment to handle the new manufacturing line.

Standardized Aircraft, Inc., 4717 District Blvd., Los Angeles, manufacturers of airplane parts, has an expansion program underway which includes the installation of approximately $50,000 worth of mechanical equipment.

Allan A. Lubitz, president of *American Firstoline Corp.*, manufacturers, distributors and exporters of a complete line of chemicals and pigments, especially French process zinc oxides, zinc carbonate, copper sulphates, nickel sulphate, etc., as well as non-ferrous metals and alloys, announces that the sales and export offices of the company have been moved from Long Island City to the Graybar Bldg., 420 Lexington Ave., New York City. Laboratory and storage facilities will continue to be maintained at the Long Island City address, where expansion of these facilities is under way. American Firstoline Corp. is also acting as sole sales agent for the Gulton line of non-ferrous metals, alloys and bearing metals.

Garvey Die Casting Corp. has been organized at Los Angeles with a capital stock of $500,000 by *M. B. Pendleton, D. A. Stevens* and *W. H. Smith*.

Bendix Aviation, Ltd., Burbank, Calif., has construction underway on a 30,000 sq. ft. office and laboratory building and a 100,000 sq. ft. factory building at 11600 Sherman Way, North Hollywood, Calif., at a total cost for buildings and equipment of $500,000. Completion is expected by October 15. The structures will house facilities for manufacturing custom-built radio accessories and aircraft hydraulic equipment.

Expansion of production facilities is underway at both the East and West plants of the *Pacific Pump Works*, Huntington Park, Calif. Seven thousand feet of floor space are being added to the east plant and 3200 feet to the west plant. New machinery costing $75,000 is to be installed. The plants will be used for manufacturing hydraulic actuating assemblies for airplanes.

Dubin Fixture Manufacturing Co., has moved from 5722 S. Main St., Los Angeles, to a new 40,000 sq. ft. building at 5717 Towne Ave. The firm manufactures store, office, restaurant, soda fountain and cocktail bar fixtures.

Peabody-Acker, Inc., 5810 South Hoover Ave., Los Angeles, has doubled the floor space for manufacturing builders' hardware and specialties.

The BIAS BUFF & WHEEL COMPANY
THE BIAS BUFF
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Jersey City, Ne
This Mark is not on any other Buff except the Genuine BIAS BUFF — made in Jersey City, N. J. for more than 20 years.

BIAS BUFFS are widely used by both large and small industrial concerns throughout the nation. The better service, the longer lasting quality of BIAS Buffs, their ultimate lower cost has given BIAS Buffs an enviable but well earned reputation.

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Norris Stamping & Manufacturing Co., 960 E. 61st St., Los Angeles, has started construction of another 10,000 sq. ft. addition to its new production plant, 5215 Boyle Ave. The new unit will furnish office facilities. The entire building program currently underway will provide 165,000 square feet of office and manufacturing space.

Harvey Machine Co., 6200 South Avalon Blvd., Los Angeles, has moved into a new building at that address for the manufacture of tools, dies, metal stampings and aircraft parts.

Universal Die Casting Corp. is occupying its new 18,000 square foot building at 5001 Santa Fe Ave., Vernon, Calif. The modern, reinforced concrete one- and two-story structure is being used for the manufacture of die castings made of aluminum, magnesium and manganese bronze.

O. F. Opperman, president of *Aircraft, Inc.*, Santa Monica, Calif., has announced that the company has acquired additional manufacturing space and is currently installing machinery for the manufacture of shell casings under a $730,800 Government contract.

Menasco Manufacturing Co., Burbank, Calif., has concluded a lease agreement with the *Defense Plant Corp.* involving the expenditure of $1,639,058 for expansion of Menasco's hydraulic strut producing facilities. The enlarged department will have a total of 82,000 square feet, representing an expansion of 56,000 square feet. New machinery, tools and equipment costing $1,500,000 will be installed, as well as a new testing and metallurgical laboratory.

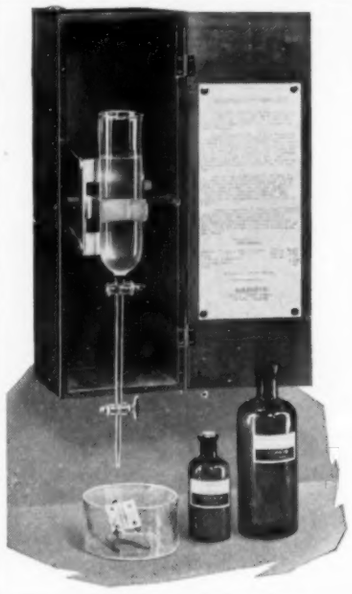
Acme Ring Co., 5814 Santa Fe Ave., Vernon, Calif., has under erection a 4,000 square foot building at 2400 East 57th St., Los Angeles, for use in expanded manufacture of piston rings.

A new assembly department with 7200 square feet of production area is being added to the *Cannon Electrical Development Co.'s* plant at 3209 Humboldt St., Los Angeles, manufacturers of cable connectors.

Production of magnesium got under way October 9 at the *Permanente Magnesium Plant*, a $10,000,000 project at Los Altos, Calif. The initial production of six tons per day is expected to be increased to 1000 tons a month by March 1, 1942. The plant was inspected early in October by Sidney Hilman, co-director general of the Office of Production Management.

Hollywood Metal Products Co., 114 N. Sycamore St., Hollywood, Calif., has acquired 3,000 square feet of additional floor area for the production of metal products for commercial and defense work.

Increased floor area for the manufacture of temperature, pressure and flow controls are provided in a new 100,000 square foot factory addition which the *General Controls Co.* is completing at 801 Allen St., Los Angeles.



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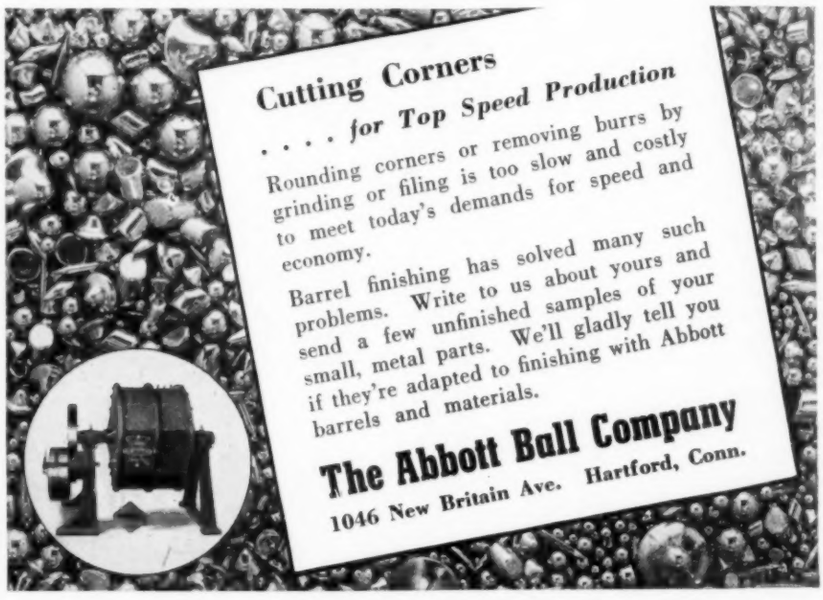
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Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.
Barrel finishing has solved many such problems. Write to us about yours and send a few unfinished samples of your small, metal parts. We'll gladly tell you if they're adapted to finishing with Abbott barrels and materials.
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Efficient *Economical*
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SULPHUR PRODUCTS CO. **Greensburg, Pa.**

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Supply Prices, October 24, 1941

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.

COPPER: Cast, elliptical, 15" and longer ..... 25⅛c. per lb.
Electrolytic, full size, .22⅞c; cut to size 22⅞c. per lb.
Rolled, oval, straight 15" and longer .23¼c. per lb.; curved ..... 24¼c. per lb.
BRASS: Cast, 80-20, elliptical, 15" and longer .... 23⅝c. per lb.
ZINC: Cast, 99.99, 16" and over ..... 16¼c. per lb.
NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus cast 47c.; Rolled, depolarized ..... 48c. per lb.
SILVER: Rolled, .999 fine per Troy oz. ..... 38c. per oz.

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.09-.10
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615
Chromic, 99%, 100 lb. drums, l.c.l.	lb.	.18¼
Hydrochloric (muriatic) Tech., 20°, carboys, wks.	lb.	.0270
Hydrochloric, C.P., 20°, bottles	lb.	.19
Hydrofluoric, 30% bbls.	lb.	.06-.06½
Nitric, 36°, carboys 1-9, wks.	lb.	.0595
Nitric, 42°, carboys 1-9, wks.	lb.	.0745
Oleic (Red Oil), distilled, drums	lb.	.12-.13
Oxalic, bbls. l.c.l.	lb.	.14½
Stearic, distilled, double pressed, bags	lb.	.14¼-.15¼
single pressed, bags	lb.	.13¾-.14¾
triple pressed, bags	lb.	.17-.18
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.17½-.19½
Butyl-normal, l.c.l., drums	lb.	.11½-.12½
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.35½
Diacetone, tech., drums, l.c.l.	lb.	.11½-.12½
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.58½
Propyl-Iso, 99%, drums, l.c.l.	gal.	.43-.47
Propyl-Normal, drums, wks.	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.04
Potash, granular, bbls., works	lb.	.0425
Ammonia, aqua, 26°, carboys	lb.	.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks.	lb.	.0445
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17
Barium Carbonate, ppted., bags, l.c.l., works	lb.	.03
Benzene (Benzol), 90%, drums, works	gal.	.19
Butyl Lactate, drums	lb.	.235
Cadmium Oxide, l.c.l., bbls.	lb.	.95
Calcium Carbonate (Ppted. chalk), c.l., wks.	lb.	.02⅞
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.06¼
Carbon Tetrachloride, l.c.l., drums	gal.	.80
Chromic Sulphate, scale, 100 lb. drums	lb.	.45
Cobalt Sulphate, drums	lb.	.71
Copper, Acetate (verdigris), bbls.	lb.	.26
Carbonate, 52-54%, bbls.	lb.	.16½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.58½
Crocus Martis (iron oxide) red, bbls.	lb.	.03¼
Dibutyl Phthalate, drums, l.c.l.	lb.	.195-.205
Diethylene Glycol, drums, l.c.l., works	lb.	.155
Dextrin, white, bags, F.O.B. Chicago	lb.	.0395
Emery (Turkish)	lb.	.08
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.09-.10
Ethylene Glycol, l.c.l., drums, works	lb.	.15½-.18½
Monoethyl ether, dms., l.c.l., wks.	lb.	.125-.155
Gold, Chloride, yellow, bottles	oz.	$19.25
Cyanide, potassium 41%, bottles, wks.	oz.	$14.20-$14.95
Gum, Arabic, white, powder, bbls.	lb.	.26-.28
Hydrogen Peroxide, 100 volume, carboys	lb.	.16-.18¼
Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.12½
Oxide (Litharge), com., powdered, bbls.	lb.	.08¼
Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Mercury Bichloride (Corrosive Sublimate), crys.	lb.	$2.39
Mercuric Oxide, tech., red, powder, bbls.	lb.	$3.11
Nickel, Carbonate, dry, bbls.	lb.	.36-.36½
Chloride, bbls.	lb.	.18-.20
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.06
Perchlorethylene, drums, l.c.l.	lb.	.08½
Phosphorus, red, cases	lb.	.44
yellow, cases	lb.	.23-.25
Potash, Caustic, 88-92%, flake, drums, works, c.l.,	lb.	.07
Potassium, Bichromate, crystals, casks	lb.	.10
Carbonate (potash) calc., wks. drums		.06¾
Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Pumice, ground, 1½ F. & coarser, bbls., wks.	lb.	.04¼
Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	$192.-$195.
Rochelle Salts, crystals, bbls.	lb.	.44
Rosin, gum, B, bbls., dock	lb.	.0306
Silver, Chloride, dry, 50 oz. lots	oz.	.37½
Cyanide, 100 oz. lots	oz.	.33¾
Nitrate, 100 oz. lots	oz.	.26⅞
Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0208
Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Hyposulphite, crystals, bags, wks.	lb.	.0250
Metasilicate, granular, 1-9 bbls.	lb.	.0335
Nitrate, rfd., gran., bbls., wks.	lb.	.029
Phosphate, tribasic, tech., bbls., wks.	lb.	.038
Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0660
Sesquisilicate, 1-9 drums	lb.	.0430
Stannate, drums	lb.	.365
Sulphate, anhydrous, bbls., works	lb.	.0215
Sulphocyanide, drums	lb.	.55-.65
Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.039
Tin Chloride, crystals, kgs.	lb.	.39-.39½
Toluene (Toluol), 2°, ind., drums, works	gal.	.32
Trichlorethylene, drums, l.c.l., zone 1	lb.	.08½
Tripoli, air floated, bgs., c.l., wks.	ton	$26.00
Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.56
Bees, yellow, crude, Brazil, 100 lbs.	lb.	No stocks
Carnauba, refined, bags	lb.	.85
Montan, bags	lb.	No prices
Spermaceti, blocks	lb.	.24-.25
Whiting, precipitated, bags, l.c.l.	ton	$18.-$25.
Xylene (Xylol), ind., returnable drums, works	gal.	.31
Zinc, carbonate, tech., bbls.	lb.	.20
Cyanide, 100 lb. kegs	lb.	.33
Chloride, tech., granular, drums, c.l., wks.	lb.	.08
Sulphate, crystals, bbls., l.c.l.	lb.	.039

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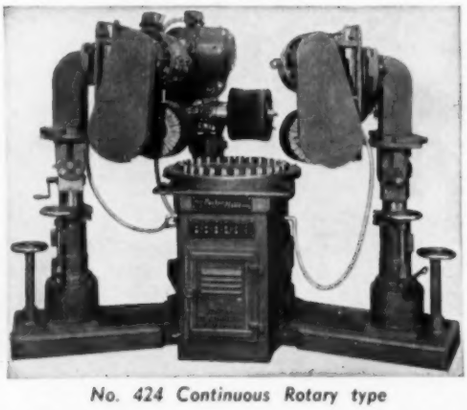

No. 424 Continuous Rotary type

•AUTOMATIC POLISHING & BUFFING MACHINES

Packer-Matic

THE PACKER MACHINE CO., MERIDEN, CONN., U. S. A.

APPLAUD METSO'S
NON-TARNISHING
EFFICIENCY
Metso Cleaner's gentle effect on soft metals reduces rejects of parts formerly tarnished. For instance, brass parts joined by a 50% lead-50% tin solder were electro-cleaned without tarnishing or blackening of the solder.
The properly balanced ingredients (alkali-silica) in Metso insure effective cleaning with a wider margin of safety. Electroplaters working with soft metals are invited to send for a two pound trial package.

METSO CLEANERS

PHILADELPHIA QUARTZ COMPANY

General Offices and Laboratory: 125 S. Third St., Phila., Pa.
Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities.
Sold in Canada by NATIONAL SILICATES LTD., Toronto, Ont.

PERMAG Cleaning Compounds

prominent in Industries engaged in National Defense Work

Dependability, speed, efficiency, economy are the factors demanded in a cleaning agent these days. Metal fabricators find PERMAG Cleaning Compounds meet every cleaning requirement to the utmost satisfaction.

When a difficult cleaning problem arises Magnuson Research Service is ready to help solve it. Write or telephone for details.

MAGNUSON PRODUCTS CORPORATION

Manufacturers of

SPECIALIZED SCIENTIFIC CLEANERS *for* EVERY INDUSTRIAL PURPOSE

Main Office: 50 Court St., Brooklyn, N. Y.

Representatives, also warehouses in principal cities in U. S.
In Canada: Canadian Permag Products Ltd., Montreal and Toronto

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McAleer is the source for *all* types of finishing materials. McAleer has laboratory facilities and technicians to solve special problems—develop new compounds.

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